PART III.

GEOLOGY AND AGRICULTURE.

A PRELIMINARY REPORT

UPON

THE FLORIDA PARISHES OF EAST LOUISIANA

AND THE BLUFF, PRAIRIE AND HILL

LANDS OF SOUTHWEST LOUISIANA,

BY

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Made Under Direction of State Experiment Stations,

BATON ROUGE, LA.

WM. C. STUBBS, PH. D., Director.

LOUISIANA STATE UNIVERSITY AND A. & M. COLLEGE.

BUREAU OF AGRICULTURE.

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CORRECTIONS AND OMISSIONS.

Page 173, line 12, omit comma and substitute comma for semicolon.

Page 175, line 17, *emboyments* should read *embayments.*

Page 177, last line, omit *above,*

Page 181, line 16, paragraph should begin with quotation marks.

Page 190, line 31, instead of *rocks were removed,* read *disintegrated rocks were not removed.*

Page 190, line 36, omit *free.*

Page 201, line 4, *upon the highways* should read *upon the prevailingly windward side of highways.*

Page 214, line 28, instead of *cale spar* read *calc spar.*

Page 215, line 8, instead of *probably* read *possibly.*

Page 221, line 33, line should begin with quotation marks.

Page 223, line 25, *selsction* should be *sclection.*

Page 229, line 1, instead of *Eeliciana* read *Feliciana.*

Page 237, line 14, instead of *Orange Island* read *Orange Sand.*

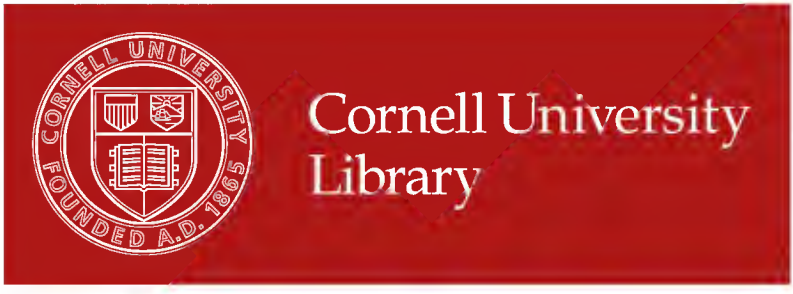
Page 238, line 30, *elevated* should be *eroded.*

Page 243, footnote, instead of *members* read *numbers.*

Page 250, line 24, *Fogus ferruginea* should be *Fagus ferruginea.*

The classification of all sections into *Lafayette* and *Columbia* is my own.

W. W. C.



OFFICE OF STATE EXPERIMENT STATION,
LOUISIANA STATE UNIVERSITY AND A. AND M. COLLEGE,
Baton Rouge, La., April 1, 1896.

Hon. A. V. Carter, Commissioner of Agriculture, Baton Rouge, La.:

DEAR SIR—The Geological and Agricultural Survey instituted in 1892 by the Stations under Dr. Otto Lerch, was discontinued for the want of funds. The appropriation by the last Legislature made immediate resumption of this important work possible. Accordingly the permanent services of Mr. W. W. Clendenin, Professor of Mineralogy and Geology in the State University and Agricultural and Mechanical College, were secured by the Station and field work inaugurated early in the summer of 1894. This work has since continued and is now being prosecuted.

Prof. Clendenin gives his services from October to March to the University and the rest of the time to field work of the survey. Dr. Lerch's reports cover the hills of North Louisiana. Prof. Clendenin took up the work where Dr. Lerch left it and has continued the survey through the Florida Parishes of East Louisiana and the bluff, hill and prairie sections of Southwest Louisiana. I have the honor of presenting herewith his preliminary report upon these sections. During the progress of this survey typical soil samples have been carefully taken and are now undergoing chemical and physical examinations in the laboratories of the Station. When all of the characteristic soils of the State have been collected and analyzed, a special report upon them will be made. This report, besides giving such analyses, will contain also a full agricultural description of these soils, their chemical requirements and physical amendments, together with such other information as may be useful to the planters and farmers of this State. The bluff lands of North Louisiana and the alluvial lands of the entire State, will be examined during the coming summer. After the preliminary sur-

vey is completed, a detailed examination, geologically, agriculturally and topographically, will be made of the entire State, which will require many years for its completion. When finished it will be a valuable addition to the literature of our State and will afford information not only to our own citizens but to the stranger seeking a home in our midst. No such work as this has ever been performed in this State, and while Louisiana is classed among the earliest settled colonies, she stands almost alone of the States of this Union, without a comprehensive geological survey. If the appropriations be continued, such a survey will certainly be consummated.

I ask that you publish this report as Part III., "Geology and Agriculture."

Very respectfully submitted,

WILLIAM C. STUBBS,

Director.

LETTER OF TRANSMISSION.

Dr. Wm. C. Stubbs, Director State Experiment Stations, Baton Rouge, La.,

SIR:—I herewith present manuscript of a Preliminary Report upon the Florida Parishes of East Louisiana and the bluff, prairie and hill lands of Southwest Louisiana.

The material for this report was collected during the summers of 1894 and 1895. Much other material for a more detailed report is gradually accumulating, which it is hoped will soon be ready for publication.

Respectfully submitted,

W. W. CLENDENIN,

Geologist.

I. INTRODUCTION.

Adopting the plan of the two reports upon "The Hills of Louisiana" by Dr. Otto Lerch, the following brief preliminary report upon the greater part of the State south of the 31st degree of North Latitude is made. The purely alluvial parishes are not here considered, inasmuch as they, being the (up to the present) chief agricultural lands, it was thought best to make a separate report upon them. Only those alluvial soils that lie in proximity to the older soils, in parishes that contain both, are here treated.

The material for this report was collected during the summers of 1894 and 1895. The appropriation for the work being made available July 1st, 1894, and I being put in charge of the survey in connection with my work in the University, the remaining months of the summer of 1894 until the opening of the University in October, were given to an examination of the Florida parishes.

Several trips were made across the section of the State embraced in these parishes by wagon, on horseback and on foot; in most of these trips I was accompanied by Prof. W. R. Dodson, Professor of Botany in the Louisiana State University and Agricultural and Mechanical College and Botanist of the Louisiana State Experiment Station.

The object being to make an *agricultural* report rather than a purely *geological*, particular attention was given to the origin, nature and depth of soil; to water supply and questions of drainage, and especially to the character of the *natural* or virgin growth upon the lands, where obtainable, as being one of the truest indices of their nature and possibilities.

This report, designed primarily for the layman in geology, has been written in a popular rather than the techinal style usually adopted for such reports. However popular in its character, no sacrifice of scientific accuracy has been made.

Few sections have been introduced into the body of the report, and no attempt at presenting the ideal substructure of the State has been made.

The superficial deposits which give character to the soils are so independent of older, underlying formations; and the topography of the region furnishes so little opportunity to study these older strata, that with the present limited knowledge of these underlying beds such an ideal section seems hardly justified.

In a special chapter a few sections made by myself, and others extracted from reports, together with some sections obtained in artesian borings, are given.

A few photographs of typical regions are presented. It is to be regretted that the method of travel often prevented a more liberal illustration.

All available information upon the region studied has been freely used; and inasmuch as this information was obtained chiefly from short articles and pamphlets long since out of print, and of extremely limited distribution, no attempt has been made always to refer the reader to the source of information.

In general I may say that the writings of Thomassy, Wrotnowski, Hilgard, Hopkins, Lockett, McGee and Stubbs upon the State, and of Spencer, Smith and others upon homologous deposits elsewhere have furnished the principal literature of this report.

Many soil samples and samples of artesian and mineral waters were taken for analysis, and in due time the results of these analyses will appear as special bulletins of the survey.

We have at present a chemist at work upon these, and Mr. E. S. Matthews, one of our graduates, has been sent on to Prof. Whitney's laboratory at Washington, D. C., to carry on the physical analysis. It is the intention, by next fall, should the survey be continued, to fit a physical laboratory at the University and make all these analyses here.

By this means there will not only be a considerable saving to the survey, but the services of students doing graduate work in the University will be available.

As the work of soil analysis, chemical and physical, is ex-

ceedingly tedious and slow, and as it is desired that the entire State shall be represented in these analyses, some time will be required for the issuance of the bulletin embodying their results.

The half year allotted to the field work of the survey in 1895 was given to a study of Southwest Louisiana, north almost to the latitude of Alexandria.

Four trips east and west across the region between the Teche and the Sabine rivers were made, and a like number north and south. Special trips were made to places of special interest, as to each of the five islands: Orange Island, Petite Anse, Grand Cote, Cote Blanche and Belle Isle; and every stream extending from the cultivable lands to the gulf was followed by boat to its mouth.

In the earlier part of the summer I was alone, but after the close of the session of the University, was joined by Mr. E. S. Matthews, who gave his time and services to the survey for the purpose of making as complete a collection as possible, of the flora of the region studied.

As in the Florida Parishes, many samples of soil were collected and shipped to the survey headquarters at the University, and are now being analyzed.

The field work of the survey for the present season will be upon the purely alluvial soils of the State, and upon the bounding "bluff" lands along the Mississippi.

The two sections of the State treated in this report, because they are widely separated by the Mississippi alluvium, and for convenience in referring to them as *geographic units*, will be described in detail in separate divisions; the Florida Parishes being considered always first and Southwest Louisiana second, being the order in which they were studied.

It should be borne in mind, however, that such a division is purely arbitrary and made for convenience; and that geologically and topographically they are similar, and belong alike to the great coastal zone that sweeps uninterruptedly from New Jersey to the Rio Grande.

The economic questions touched upon in this report are to be taken up and studied exhaustively, and the results will appear probably as bulletins.

A complete, detailed and final report upon any section of the State must wait upon a topographic survey, which, with the present limited appropriation cannot be undertaken.

Until then, though economic questions depending upon surface geology may be studied with much profit, profounder questions of scientific interest and also of economic importance must remain unsolved.

II. DESCRIPTION OF AREA.

GEOGRAPHY AND HISTORY.

The section of Louisiana styled the "Florida Parishes" lies south of the 31st parallel of latitude, between the Mississippi river on the west and the Pearl river on the east; and is bounded on the south by Lake Pontchartrain, Lake Maurepas and Bayou Manchac.

It includes eight parishes, viz.: St. Tammany, Washington, Tangipahoa, St. Helena, Livingston, East Baton Rouge, East Feliciana and West Feliciana; and comprises an area of about 4500 square miles.

This section was not a part of the Louisiana purchase made by President Jefferson in 1803, but continued as part of Florida until 1810, when it was taken possession of by Americans.

Bordering upon the Mississippi and Pearl rivers, with many smaller though navigable streams penetrating to its interior, and comprising both hill and alluvial lands, the Florida Parishes were early settled and became the seats of some of the handsomest plantation homes of the South.

The parish of Feliciana was so called by the Spaniards in recognition of its salubrity of climate, beautiful variety of forest, its clear waters and fertile soil.

Baton Rouge, the capital of the State, the seat of the University and A. & M. College and State Experiment Station, and the third largest city in the State, is the chief commercial and educational centre of these parishes. It is situated in the parish of East Baton Rouge, upon the Mississippi river at the southern limit of the river bluff, and the beginning, upon the eastern side, of the Mississippi alluvium.

Pre-eminently an agricultural section, the variety of soil is very great; and the diversity of crops has produced a diversity

of interest that is displayed in the opposing views held by the residents, upon national questions of economics and finance.

St. Tammany parish, long the country home of many wealthy families of New Orleans, because of the delightfulness of its climate, is constantly growing in favor; and we find not only many summer hotels along the northern shore of Lake Pontchartrain, which are crowded to their utmost capacity during the summer months by people who wish to get out of the city for a time, but also several very pleasant resorts in the interior built up around artesian and other mineral waters that possess healing virtues.

When the question of mineral waters can be fully investigated it is more than probable that many who now go thousands of miles in search of health giving waters will find in their own State, and practically at their doors, springs and wells in every respect equal to those they annually make tedious and dangerous journeys to reach.

Southwest Louisiana, as here described, includes the greater part of the region west of the Atchafalaya river to the Sabine; and lying south of the latitude of Alexandria.

The parishes constituting this area are St. Mary, Iberia, St. Martin, Lafayette, Vermilion, Acadia, St. Landry, Cameron, Calcasieu, and parts of Vernon and Rapides.

The first five of these constitute what is known as the "Attakapas" country, which derives its name from a tribe of Indians who once occupied this region, and whose descendents are still found there in small numbers. The occupants of the "Attakapas" region have been pleased to style it the "Garden of Louisiana," with how much reason I leave it for this report and personal investigation to determine. This is the scene of much of the plot of the beautiful legendary poem, Evangeline; as also the home and safe retreat of that omnipresent, sometime pirate, Lafitte.

Search for this pirate king's buried treasures is constantly made by credulous people, using for the purpose "divining" rods varying in style from that used in the time of Moses to the modern peach or willow fork. Especially is this true upon and near the five islands, people coming scores of miles to join in the search.

Were but one-half the energy thus wasted employed in improving their farms, these people could much more justly claim for their section the proud title of "Garden of Louisiana."

On the south the area described is washed by Atchafalaya, Cote Blanche and Vermilion Bays, arms of the Gulf, and further west by the Gulf of Mexico itself. The Sabine river marks the entire western border between this area and Texas.

Much of the region has been recently reclaimed from the coast marsh and converted into prosperous farms. No other part of the State shows a greater degree of modern thrift and prosperity.

Growing and thriving towns are found along the railroads, and well equipped farms upon land that a decade ago was considered worthless for everything except a pasture ground for roaming herds of half-wild cattle and horses. New lines of railroad are building, and others have been projected through this part of Louisiana, and the era of prosperity seems only to have dawned.

The Attakapas country is the home of the Acadians, who found here a retreat when so ruthlessly driven out of their far off Canada homes. Their homes in Louisiana, with their accompanying grounds display a peculiar and distinct style of architecture and adornment.

The Teche country is too well and favorably known to require special description. Upon its banks are found some of the oldest and handsomest homes in the South. Some of the most prosperous, wide awake towns of the State are found along its banks, where the Southern Pacific railroad touches its western bends

Southwestern Louisiana includes even a greater variety of soil than the Florida parishes; having in addition to the hills, the flats, the "bluff" and the alluvial bottoms of that section, the "prairies" and a large area of redeemed coastal marsh. On this account a corresponding greater variety of crops is planted and living *at home* is much more generally the rule. Being recently largely settled by small farmers from the Northwest, who own and cultivate their own farms, this section, like much of

North Louisiana, exhibits the desirable condition of being owned in small tracts and occupied by the owner.

TOPOGRAPHY AND DRAINAGE.

Next to climate, perhaps the most important questions to the immigrant to any region are those of Topography and Drainage. Upon these will depend whether he may make his home in healthful regions of the well drained uplands, or be forced to the less healthful lowlands; whether the refreshing rains shall purify the atmosphere by removing the products of death and decay, or shall produce disease by bringing from other and more favored localities these same products to vitiate the air by decaying in stagnant lagoons and swamps.

Usually a geographically old region is a well drained region. Indeed the development of topographic form is usually so rapid, that any except *very recent* deposits exhibit more or less perfect systems of drainage. As the rapidity with which the topography of a region develops is a function of its attitude to sea level, and as oscillations of the land are continuous, a region geologically very young may be sufficiently elevated to display in a short time an adolescent or even mature topography. On the other hand, topographic forms in all stages of maturity may be arrested in their development by subsidence of the land; and if this subsidence is sufficient, be buried by newer deposits.

A section inland one hundred miles from almost any point upon the Louisiana coast would cross almost every stage of development of topographic form from the most helpless youth to full maturity.

Three distinct types of topography are displayed in the Florida Parishes, represented by the "pine hills," the "bluffs" and the "pine flats."

The "pine hills" constitute the inter-stream areas lying north of a limit, roughly drawn, beginning in West Feliciana near where the Woodville and Bayou Sara railroad crosses the State line, and extending thence southeast to the Amite a few miles north of the mouth of the Comite river; thence eastward by a

zigzag course to the Pearl river near the mouth of the Bogue-chitto.

This region displays a topography characteristically mature. The hills are all water sheds, and there remain no undrained interstream uplands.

Here we see a topography developed in a former geologic age, and ushered into the present age without essential change. The burial and resurrection during and at the close of the last continental subsidence followed so close the last upon the first, that only a thin veneering of sediment was deposited; shrouding but not concealing the mature character of the topography.

Albeit the shroud, is thin; subsequent time and attitude have not enabled the agents of degradation to remove it, and we see this section still in its grave clothes.

The streams occupy their resurrected valleys even to their tributaries of the third and fourth order. These latter begin often with such exceedingly steep gradients as to resemble enormous *bath tubs*; and their rapid fall carries them quickly to the level of the parent or remoter master streams.

The primary streams occupy trenches in deposits, made during subsidence and principally by themselves, in their own former valleys. In no case was I able to find where they had trenched to the old bed.

The character of the soil and the protection afforded by the grasses of this section have reduced erosion almost to a minimum ; and the streams, though rapid, are essentially clear.

The complete, dendritic systems of drainage, in steep-sloped, V-shaped valleys with strong gradients, bespeak rapid development upon a land that stood much higher above sea level than does the present land. Likewise the easy reference of the crests of hills and ridges to one plane shows this to be a dissected plane, originally topographically similar to the pine flats to the south.

"The "bluff" section includes the remaining portions of the Felicianas and East Baton Rouge south of the "pine hills," and Livingston parish eastward to the Tickfaw, excepting small areas of the Mississippi and Amite alluvium.

Here we have a topography that may be styled adolescent.

The primary streams run in channels with steep, often vertical banks; and the secondary and tertiary branches have cut gorge-like trenches through the latest deposit, the "bluff," and often deep into the underlying beds of the next previous geological age.

The narrow, V-shaped valleys with extensive level interstream areas attest the youthful character of the topography.

Beneath the mantle of "bluff" the dissections by the streams discover a mature topography in all respects like that of the "pine hills;" and, indeed, we find that the level, imperfectly drained uplands of this section are the result of a thickening of the veneer that mantles the pine hills, as we approach the principal sediment transporting stream, the Mississippi.

This thickening along the banks of the sediment-laden river, in essence a *natural levee*, was sufficient to entirely obliterate former topographic forms, filling up the valleys to the level of the ridges, and covering all with an even coat of sediment.

River valleys were buried beyond possible resurrection and the drainage lines of to-day are independent of former systems. Ten or twelve miles back from the river the influence of former topography begins to be seen in the streams reoccupying their resurrected channels.

Erosion over the "bluff" area is rapid, and the streams correspondingly muddy. Enormous quantities of silt and sand are carried into the master streams after every rain.

The third type of topography is displayed by the "pine flats," a topography as yet in its most helpless youth.

Limpid, clear streams meandering and loitering through stretches of level which rise but little above their own surface; with almost vertical banks and depth out of proportion to their width, they form a characteristic feature, with few homologies in the United States.

Broad, level, poorly drained inter stream areas—so smooth and level that the precipitation runs off in a practically unbroken sheet, thus having little effect as an agent of erosion—characterize these flats.

The larger streams flowing through them doubtless are extensions of resurrected valleys; but the smaller lines of drainage are but beginning their work, and their meandering courses show how completely they are at the mercy of the slightest obstacles.

With scarcely any draught upon them, for the work of transportation, the energy of their currents is expended in deepening their channels. These flats grade insensibly into the coastal sea marsh now forming, and are doubtless of similar origin.

In extent and position they occupy all of that section of the "Florida Parishes" south of the "pine hills" and lying between the Tickfaw and Pearl rivers. Northward along all the principal streams flowing through them, embayments of the flats extend; and in the cases of the Amite, Tangipahoa and Bogue-chitto these embayments reach beyond the State line. The embayments of the Tickfaw and Chefuncta reach almost to the limits of the State, and of smaller streams, well into the hill section.

Each of the Florida parishes is reached by one or more navigable streams.

The topography of these parishes is on the whole extremely simple. No local disturbances seem to have occurred to interrupt the natural though varying processes of erosion and deposition.

The attitude of the strata indicate slow and gentle regional oscillation through a considerable vertical distance. The evidence points to the present attitude being much nearer the bottom of the swing than the top. The land probably stood thousands of feet higher than its present level; but during the deposition of present surface strata it was never more than a few hundred feet lower than at present.

Therefore we find only gentle dips in the strata, and the ridges have been carved out of approximately horizontal deposits.

The abnormally rapid fall of the tributary valleys to the bottoms of the master streams, and of side valleys of the

second and third order, having often a bath tub appearance, indicates the great altitude of the land when they were formed.

The easy reference of the ridges to one plane, and the horizontal attitude of the strata cut through by the valleys show that the irregularity of surface is due to erosion of a once continuous plain like the present "flats."

Unconformities of strata are observed, but it is *unconformity of erosion*, and the overlying and underlying strata are essentially parallel. Within the pine flat embayments that accompany the principal streams into hills is usually a second lower flat, the flood plain of the present streams. This is a product of the streams now and in recent times.

All the types of topography displayed by the Florida parishes are found in Southwest Louisiana: the "pine flats," the "bluff" and the "pine hills;" and in addition the "prairies," which may be considered distinct from all.

The "pine flats" are confined to Calcasieu parish, and extend in an east and west zone along the southern base of the hills, southward as far as west fork of Calcasieu river, and from the Sabine on the west to the Calcasieu on the east. They cover an area of about twenty-five sections, and are from fifteen to twenty miles in width on the western border of the State and extend up the Calcasieu about to the junction of Black creek with that river.

While wet, and characterized by the same vegetation as the "pine flats" of St. Tammany, these flats differ from those considerably topographically, as also in character of soil.

The primary streams appear to follow mainly their resurrected valleys, or extensions of these, and the development of drainage systems has progressed far beyond anything displayed by the pine flats of the Florida parishes. However, the topography is still young, and the interstream areas poorly drained.

The flats grade imperceptibly into the hills, and *do not* extend headward along the primary streams as "second bottoms." On the other hand, they pass as imperceptibly into the "prairies" with scarcely noticeable change other than the failing of the forests.

All over these flats, but not confined to them, is found a peculiar topographic feature to be discussed later—the mounds.

While the subsoil and underlying formations are in general the same as found in the Florida Parishes, yet the chocolate colored, silty loam, found over the prairies to the east spreads as a very thin veneer over the flats.

The "bluff" regions are much more limited in extent than east of the Mississippi, and are found only as tattered remnants of a former much more extensive plane, capping hills and ridges that mark the sometime western shore of the greater Mississippi. Their surface extension is small, but their influence as a substratum is felt over the greater part of this section. Appearing in northeastern Rapides and northwestern Avoyelles in detached, island "prairies," in, or bordering along the Mississippi and Red river bottoms; appearing again in erosion tattered areas along Bayou Rouge; then reappearing along the west bank of Cocodrie and Courtableau bayous, above Washington in St. Landry parish, and extending thence southward to within a few miles of Cote Blance Bay, in a continuous zone of varying width, the "bluff" deposits present a characteristic soil, though too limited in area to be of importance in the development of topographic form. Westward the deposit, in modified form, sinks gradually, but nowhere deeply, beneath the chocolate colored loam of the prairies, of which more in a later paragraph.

The "bluff" deposits here, as in West Feliciana, have the same color and consistency, and weather into like steep-sloped minarets and spires, standing indefinitely in vertical walls without crumbling.

The bayous, "marais" and "coulees" that meander through or extend across this "bluff" area are very unlike the hastily developed drainage system of this formation in West Feliciana. Nowhere do we find the deep, gorge-like valleys; but instead meandering streams in what appear to be old channels, inherited from streams that from some cause became so inactive as to meander aimlessly over a region with faint slope, being turned aside by the slightest obstacle, as a river through its delta or in its extension across a level, recently elevated above sea bottom.

Lying well above the alluvial lands to the east, these "bluff" lands are capable of complete and thorough drainage.

Inasmuch as the eastern margin of the "bluff" is highest (being probably the natural levee along the western bank of the ancient Mississippi) and slopes gently to the west, the natural drainage of this region is westward into the "coulees" and "marais," and through those into the headwaters of the Mermentan, Vermilion or some of the shorter coastal streams.

These "coulees" and "marais" are remnants of old, abandoned river channels, that by their clogging have frequently produced extensive high level swamps.

Their meandering beds are seen in considerable numbers from Washington southward beyond Jeannerette, reaching their greatest development in Grand Marais south of New Iberia. It would appear that during the emergence of the "bluff" lands of this region, the Mississippi, during high floods, discharged waters to the southwest across these areas; but with further elevation, combined with decreasing volumes of water in the Mississippi, these channels were permanently abandoned, and gradually developed into the "coulees" and "marais" of to-day.

The "pine hills" of this section present no essentially new features from those of the Florida Parishes. The topography is mature, and the streams occupy their pre Columbian valleys. Erosion now goes on very slowly, and the streams are prevailingly clear and limpid. The same steep slopes of tributary streams, with their ultimate branches beginning with the peculiar "bath-tub" depressions are seen here as east of the Amite.

The "pine hills" here occupy the northern third of Calcasieu, the northwestern corner of St. Landry, most of Vernon, and Rapides parish with the exception of a zone of Red River alluvium about twelve miles wide, that crosses the parish in a northwest and southeast direction, and divides the hill section into two parts, occupying the northeastern corner and western half.

The "prairies" of Southwest Louisiana are worthy of being placed as a distinct class among the topographical features

of the State. They have no counterpart in the State east of the Mississippi river, and only detached and very small homologies in other parts of the State. With their stream accompanying, narrow strips of hardwood trees, they constitute about one-half of the area between the base line and the sea marsh, into which they pass imperceptibly. With the exception of marginal strips of timber bordering the sluggish streams, they are treeless. They are probably contemporaneous in origin with or perhaps a little younger than the pine flats, from which they differ chiefly in the character of their deposits. For the most part level and poorly drained, their natural drainage lines seem to be inheritances from their former marsh condition, when they existed as marsh bayous, similar to those of the coastal marsh of to-day.

As all streams, even to their remote beginnings are tree-skirted, it would suggest that the prairie condition is a result of want of drainage.

Two special topographic features are prominent throughout the prairie region; in the west *mounds*, in the eastern part *natural ponds*. These are so noticeable, and in the case of the mounds, play such an important part in giving character to the region, that they deserve special consideration.

THE MOUNDS.

Though not distinctive of the prairie, as these mounds extend throughout the pine flats, into the sea marsh and even into the pine hills, they attain their greatest development in the prairies around and near the sulphur mine in Calcasieu parish. From this point as a center, these mounds become gradually less numerous and smaller in every direction until at a distance varying from 25 to 75 miles they cease to be of sufficient development to attract attention. Their limits are further in an east and west direction, extending eastward almost to Abbeville and westward far into Texas. In the direction of the pine hills the mounds extend beyond the flats, being found farthest along the bottoms of the larger streams. To the south, southeast and southwest they extend far into the sea marsh, but their limits in these directions have not been traced.

In their greatest development they may be fifty feet across the circular base, and their rounded dome like tops rise ten feet above the surrounding prairie; this after long erosion and tramping by the hosts of cattle and buffalo that have pastured here, and sought them because of their dryness and superior grass.

In structure they are found to be much more sandy than the surrounding land, and the deposit of calcareous clay that is found as a subsoil throughout the prairie is absent in them.

Always in zones and often in lines, many times having the appearance of being artificially laid out in intersecting systems of lines, they are never found solitary.

Several explanations have been offered to account for them, but as yet none has been generally accepted.

Immigrants from the northwest, having seen mounds accumulated by the winds about some obstruction, as a bush, have attributed them to wind action.

Their resemblance to colonies of ant hills seen in certain parts of the world has caused them to be attributed to these insects; and the fact that ants are found at the present time occupying some of them gives color to this explanation.

Dr. Hilgard accepted this as unquestionably the explanation of their origin, as shown by the following extract from his report of a "Geological Reconnoissance of the State of Louisiana." Speaking of "Prairie Faquetyke" he says:

"On this prairie we first observe, in considerable numbers, those singular rounded hillocks which dot so large a portion, both of the prairies and the woodlands of Southwestern Louisiana, and adjoining portions of Texas. With a maximum elevation of about two feet above the general surface, they have a diameter varying from a few feet to twenty or thirty; their number defies calculation.

"They do not show in their internal structure any vestige of their mode of origin; or rather, being totally devoid of structure of any kind, they merely prove by their material that there has been a mixing up of the surface soil with from two to four feet of the subsoil. They are altogether independent of formations underlying at a greater depth, and it seems impossible to assign to

them any other origin than that historically known of their brethren in Texas, viz: that of *ant hills*.

"As to the physical or moral causes of the wholesale slaughter or emigration of this once teeming population, deponent saith not. Perhaps some of the aboriginal Attakapas tribes might, if consulted, still be able to bear testimony upon the subject."

Neither of these explanations will account for the gradual decrease in size and numbers as they are farther and farther from a given center, nor for their zonal and often linear arrangement; neither will they explain their more sandy character than surrounding surface deposits.

As coming much nearer their true explanation I quote the following from Dr. F. V. Hopkins' First Report upon the Geology of Louisiana. In speaking of the sulphur deposits of Calcasieu, found in boring for oil, he says:

The wells are bored in a marsh, often three feet under water. Now this marsh is dotted in every direction with mounds, generally circular, and from thirty to fifty feet in diameter and from three to five feet in height. Their appearance is singular, and is rendered yet more effective by the fact that while nothing but marsh grass can grow between them, they are covered with luxuriant clumps of timber trees, whose grouping could not be excelled by the best landscape gardener. These mounds are not peculiar to this marsh, but are widely scattered over our prairies, and the lower parts of the drift; * * * but they are larger and more numerous here than elsewhere. In structure they are always more sandy and porous than the surrounding soil. These phenomena admit of explanation upon theories already accepted by scientific men * * *.

"We have examples at the mouth of the river of the force exerted by the gases arising from the decay of buried driftwood. I refer to the formation of the "mud lumps" at or near the passes. These are described by Thomassy as heaped up by the continual flow of water and inflammable gas, i. e., marsh gas, bubbling up from a great depth, and bringing with them the lead colored clay of which they are formed. When the delta shall have made

out past these mud lumps, and the decay of vegetable matter shall have been complete, the appearance presented will closely resemble that now seen in our "pimpled" prairies, and especially the marsh above the sulphur bed.

"The mud lumps will no longer have each its formative stream of gas and water, but will be mounds in a level, alluvial formation. The varied phenomena of the region thus aid in explaining each other. The sulphur was formed by reducing the gypsum with the vegetable matter. The carbonic acid, olefiant gas and marsh gas produced by the process have each left the appropriate proof of its presence, i. e., the limestone stratum No. 5 contains the former, the petroleum is made of the olefiant gas, and the mounds are the vent holes for the latter."

Now, however close the analogy in origin of these mounds to that of the mud lumps at the mouth of the Mississippi, their composition and structure both point to a force acting from *below*, and similarity of the underlying deposits to those of the cretaceous ridge which terminates southward in Belle Isle, where undoubted disturbance has occurred, suggests that here, too, earthshocks were produced, with more or less fracturing of the strata. Such fractures would radiate and rebranch from a central region, and along the radial and branching fractures the gases would find an easy passage, and above them, around the vents through which they reached the surface, mounds would be produced.

This would easily account for the zonar and linear arrangement of these mounds, and likewise for their composition and structure, the excess of sand coming from the underlying Lafayette.

If ants have to any considerable extent occupied these mounds I think the explanation of such occupancy in the past may be found in the fact that then, as now, these were the highest and driest spots in the region.

In Texas, forty miles southwest of Sulphur Mine, these mounds are found, and many of them are capped by ant colonies, while no such colonies are found in the surrounding intermound prairie.

Agriculturally these mounds exert a strong influence. In

those regions devoted to rice they are difficult to flood, and being sandy and without the substratum of clay, when levelled serve as a slow means of draining off the flooding waters. On the other hand, for those crops that do not require flooding, these mounds and their immédiate vicinity offer the most desirable conditions.

NATURAL PONDS.

With the disappearance of the mounds in the prairies eastward appear numerous circular shallow bodies of water or "natural ponds." In area varying usually from half an acre to two or three acres each, they constitute as characteristic a feature of the landscape as the mounds further west.

Covered with water for the greater part of the year, even during the months of least rainfall, they are for the most part occupied by water plants, both shrubs and annuals. Into these the cattle wade to escape the troublesome flies, and upon leaving, carry away with them an appreciable amount of mud. This suggests their origin.

The region, naturally flat and poorly drained, had originally an irregular surface upon which water stood in pools. The region was once the pasturing ground for enormous numbers of buffalo. These seeking the pools in which water remained longest, would wallow in them in order to cover themselves with a protecting coat of mud against pestiferous insects as flies, gnats and mosquitos. This process repeated day after day for century upon century resulted at last in these "natural ponds," which in all respects resemble the "buffalo wallows" of the great Western prairies.

Being easily and completely flooded, where it is possible to drain the water off from these ponds, they make excellent rice fields.

The streams bordering upon and transecting Southwest Louisiana are all navigable in their lower courses, and most of them far into the region. All are characterized by deep channels through the "flats," "prairies" and coastal marsh until the point where tide water is usually met, when the stream shallows

and spreads into a lake like basin, below which, and especially at the mouth where comparatively dead water is met, the rivers are much shallower, and navigation is greatly impeded.

Such lakes are Sabine, Calcasieu, Grand, an expansion of the Mermentau, and Grand in the Atchafalaya.

The government has spent, and is annually spending considerable sums of money to keep the river mouths or "passes" open to admit large steamers, but so far only poor success has rewarded the outlay, and now only a few light draft steamers ply these waters.

The coastal marsh, which is much more important in Southwest Louisiana than in the Florida Parishes, is but an extension of the prairies, and with a slight elevation of the land would become such. In their gulfward half they are marked by a network of interbranching bayous, with river-like width and depth and with vertical banks that rise from one to three or four feet above the mean level.

In width and depth these bayous might suggest an inheritance from a former geological period, when the attitude of the land was such as to permit the development of perfect systems of drainage, and of such duration as to allow the streams to cut their beds deep and wide. Yet such inheritance is not at all probable, and the bayous are most certainly developments in the marsh itself.

With every incoming tide thousands of square miles of marsh are flooded, and with the fall of the tide to a considerable extent drained. The conditions being favorable to the growth of a multitude of marsh reeds and grasses, the entire region is covered by a dense growth and accumulation of vegetable matter, which retards both the flooding and draining of the marsh. Such obstruction being unevenly distributed, the inflowing and outflowing tides will follow the line of least obstruction, and thus we have the genesis of the bayou.

No sediment is brought to the region nor carried away from it save that gathered along the line of drainage itself; and as the energy of the current is reserved almost wholly for the work of erosion, down to a certain limit the depth of the bayou will

be increased by every incoming and outgoing tide. The sediments gathered from the bayou bed by the rising tide are spread over the surrounding marsh, but most along the margins of the bayous themselves, the greatest check in the current being there. On that account we find the bayou margins higher than the further removed swamps, or the "front" and "back" lands so well recognized by all residents of river basins that are periodically flooded.

The sediments eroded from the bed by the outgoing tide are deposited near the mouth of the bayou, and in this they resemble all rivers reaching the gulf from the interior; becoming rapidly more shallow as they enter or near the gulf.

The course of the marsh bayous being a matter of accident, and in nowise dependent upon the inclinations or character of the deposits into which their beds are eroded, they branch and interbranch in the most perplexing manner; producing a maze of channels which can be traversed only by the aid of a chart.

True, by following the current at ebb tide one would come eventually to the gulf, but at what particular point, unless perfectly acquainted with the marsh it would be impossible for him to predict; for connecting cross-bayous are frequently wider and apparently of greater extent than those that reach the gulf.

One of the most notable features that breaks the monotony of the almost featureless topography of the coast marsh is the series of long, narrow, bar-like islands in the southern half of the marsh; which, because of their usual growth of live oaks are known as "chenieres." Their slight width and general parallellism to the coast, as well as their composition and structure proclaim them to be homologues of the shell beaches that are forming in various places along the present coast. They support a considerable population, whose chief occupation is the herding and shipping of great numbers of half wild cattle that thrive and fatten on these marshes.

The coast marsh occupies almost one hundred sections of land west of the Atchafalaya river, and is in general about thirty miles in width. Many thousand acres in Calcasieu and Cameron parishes have been reclaimed, and are now in profitable culti-

vation. Hardly an acre of this land but is likewise reclaimable, and when so reclaimed will take its place among the most desirable agricultural sections of Louisiana.

Concerning the five "islands," Orange, Petite Anse, Grand Cote, Cote Blanche and Belle Isle, which rise as lone sentinels in the midst of the coast marsh or on the margin of the prairies, their description is reserved for a special section.

GEOLOGICAL HISTORY.

The Florida Parishes are a part of the coastal plain that borders the Atlantic Ocean and Gulf of Mexico from New England to and beyond the Rio Grande river. The coastal lowland, averaging about 150 miles in width may everywhere be divided into two and often three distinct types of topography.

The "low grounds" of the Carolinas and the "pine meadows" and "pine flats" of Alabama, Mississippi and Louisiana constituting the seaward division of the coastal plain are, as has been described, topographically young. Their illy drained areas extend up all the transecting primary streams and many of the secondary.

The landward division of the coastal plain is topographically mature. Its perfectly drained surface is made up of a succession of hills and ridges whose even crests show them to be the tattered remnants of a former peneplain.

The third type of topography is found as bordering zones along the great streams whose tributary sources were in the regions of the northern continental ice sheet. While the sediments constituting the strata of this type were deposited quite as late as those of the pine flats, yet the attitude of the land is such that topographic forms have been of rapid development, and the topography of these areas is not inaptly styled adolescent.

This coastal lowland, constituting the most recent important addition to our continent, belongs to the *Lafayette* and *Columbia* formations.

These formations, recent subdivisions of the *Orange Sand* of Hilgard and other geologists who studied this region, while not fully determined as to exact geological position,

are probably late Tertiary and Quarternary. Being almost destitute of fossils, biologic criteria cannot be used in fixing them in the geologic section, and resort must be had to the principle that "geologic history may be read from the configuration of the land as readily as from the contemporaneous rocks and fossils." This being the case a geologic province should include alike the areas of degradation and concurrent deposition.

This new significance of topographic forms enables us to correlate widely separate deposits by means of their concurrent, intermerging area of degradation. It is now recognized that any formation "represents a series of deposits laid down by a definitely limited set of agencies in a definitely limited area within a definitely limited period of time;" and that it "thus expresses tangibly certain conditions of a certain part of the continent during a certain period of geologic time."

The Lafayette formation must therefore be studied alike in the deposits of clay, sand and gravel, and in the vastly degraded region which furnished these materials; and the history of the Columbia formation is read equally well in the deposits of the time and in the deeply eroded strata of the Lafayette.

Both Lafayette and Columbia formations are well developed in the Florida parishes. The Lafayette constitutes the "pine hills," with the exception of a thin veneer of yellowish brown loam, and extends beneath the Columbia in the flats. The Columbia formation is chiefly confined to the "pine flats" and "second bottoms" of the streams; but in its upper member, the yellowish brown loam, spreads mantlewise over all the hills.

BRIEF HISTORY OF THE LAFAYETTE FORMATION.

While the geologic age of the Lafayette formation has not been exactly determined, this much is definitely known: It is directly overlain, though uncomformably by the Quaternary Columbia, and underlain, with similar unconformity, by the Grand gulf and other formations of Tertiary age. There is reason to believe that it forms a connecting link between these geologic periods, and belongs in part to both. Of its general characters and distribution, the following from the Twelfth An-

nual Report of the United States Geological Survey,* very accurately describes the formation in the Florida parishes:

"The Lafayette formation may briefly be described as an extensive sheet of loams, clays and sands of prevailing orange hues, generally massive above, generally stratified below, with local accumulations of gravel along waterways. The deposit varies in thickness with the strength of local streams; and the materials combine the characters of the areas drained with those of the underlying formation. On the whole the formation is so characteristic as to be recognized wherever seen. This formation is "the most extensive in the United States" and "is more uniform, petrographically, than any other formation of even one fourth of its extent."

"In general distribution the formation is known to expand and strengthen southward from a few isolated remnants crowning the central axis of peninsular New Jersey, a few miles south of the Raritan, to a thick deposit forming a terrane 40 or 50 miles wide on the Roanoke; to expand thence southward, in a broad zone, at first widening, but afterward narrowing with the encroachment of the overlapping coastal sands upon its area, quite across the Carolinas; to form the most conspicuous terrane of Central Georgia, where it strethes from the Falls line to the inland margin of the coastal sands all the way from the Savannah to the Chattahoochee; to again expand greatly in Alabama with the contraction of the overlying coast sands until it forms an essentially continuous terrane, stretching from the fall line at Montgomery and Tuscaloosa to the waters of Mobile bay and to within a dozen miles of the gulf in the southwestern corner of the State; to expand still more in the Mississippi embayment until it overlooks the great river in a practically continuous scarp from Baton Rouge to the mouth of the Ohio; to reappear in extensive remnants beyond the Mississippi in Central and Southwestern Arkansas; and to extend over a vast area in Northwestern Louisiana and Southeastern Texas, and almost certainly to stretch thence southwestward in a con-

*The Lafayette Formation—W. J. McGee.

tinuous belt toward the coast and as erosion tattered remnants inland, quite to the Rio Grande."

"If the direct observation be supplemented by legitimate and necessary inference, the formation must be so extended as to bridge the valleys from which it has been degraded and stretch beneath the various phases of the Columbia formation well toward the Atlantic and gulf coasts."

"With this inferential extension the field of the formation becomes co-extensive with the coastal plain of the Atlantic and gulf slopes (including perhaps Florida) and assumes an area of 200,000 or 250,000 square miles. Over the whole of this vast area the Lafayette formation must originally have stretched, and over all of this area, except in the deeper Mississippi embayment and in the southwesternmost gulf slope, it must have possessed the wonderfully uniform composition and structure exhibited to-day by its stream carved remnants."

The Florida parishes lie wholly within the area above described, and though veneered or deeply buried by the later Columbia formation, undoubtedly have for their foundation the deposits of the Lafayette. In the pine hills of the northern section the thin coating of Columbia deposits is readily cut through, and the characteristic Lafayette is displayed in all the road cuts and washes.

The streams, though having their valleys eroded in the Lafayette, usually run through alluvial deposits of their own recent formation, so that few sections of this epoch are seen in their banks. Though deeply dissected by them, no evidence was discovered of any of the streams bordering on or extending into this region, except the Mississippi, having cut entirely through the Lafayette and revealing the underlying Grand Gulf formation.

The Pearl river, the second deepest and most active stream of the region, where it is deflected against the hills in Northeast Louisiana, displays in its bank characteristic Lafayette deposits and nothing lower.

The materials of the Lafayette, as a rule, are not far travelled, being largely from local sources. Only in the vicinity of

considerable streams that have their sources far in the interior of the continent do we find materials that cannot be traced to their nearby source.

The numerous lines of pebbles observed in the red sandy clay and loam are as a rule subangular, thus attesting their brief journey. They are generally cherty in character. In the pebble beds near the large streams these are mixed with much more rounded pebbles of quartz, agate, jasper, and frequently of crystalline rocks that are found far to the north. Their rounding betrays their long journey, and their mineral character proves them strangers to the older neighboring terranes.

By far the greater portion of the materials of the Lafayette formation is sand mixed with red loamy clay. This constitutes more than three-fourths of the deposit. The color, red at the surface, grading into bluff below, is due to the oxides of iron so abundant in all the newer deposits of the coastal plain. The red color of the sand and pebbles is not inherent, being imparted by the iron as a coating, and may be washed away leaving beautiful snow white sand banks.

This disseminated iron often becomes concentrated into nodules and shells, or as a cement forms the beds of iron conglomerate so common at or near the surface in the hills of the Florida parishes. The beds of sand and pebbles often show cross-bedding and frequent partings of clay. This variation in structure and materials indicates varying and fitful currents and wave-action.

The vast accumulations of sediments in the brief epoch of the Lafayette formation suggests two opposite and consecutive conditions: a pre-Lafayette depression of the continent to the north that brought the surface so near to the base-level of erosion that rocks were removed by the greatly reduced activity of the streams; followed by an upward oscillation about an axis at first within the land but which migrated far to the southward.

The low altitude of the sediment producing land and sluggish character of the streams of immediately free pre-Lafayette time is shown by the fine-grained character of the underlying

Grand Gulf formation, and the deeply weathered but unremoved rock materials in the areas which furnished sediments for the Grand Gulf strata.

The subsequent upward swing about an axis at first within the continental limits is indicated by the renewed activity of the streams which deeply eroded the Grand Gulf formation, and the gradual encroachment of the Lafayette sediments upon this eroded surface.

That the Lafayette sediments were deposited first upon a *sinking* area is indicated by the underlying coarse sand and pebble bed; and that the formation closed upon a *rising* surface is equally clearly indicated by the capping of conglomerate so common throughout the region.

It would seem highly probable that this *continued* elevation during later Lafayette deposition and erosion is that which raised the continent to such an altitude as to make the accumulation of ice of the Glacial Period possible.

This shifting of the axis of oscillation from an interior position southward will explain the greater thicknesses of the formation toward its interior margin than nearer the coast. What the extent of the migration was is not known.

If, as Dr. J. W. Spencer's studies in the West Indies* seem to prove, those islands became part of the continent and received Lafayette sediments, the axis must have shifted to a position far south of them. It will appear that the Columbia formation seems to have been formed first upon the rising and later upon the sinking surface of the Lafayette.

The unequal heights at which Lafayette sediments are found is due in part to unequal erosion and removal, but in much larger part to a slight warping during oscillation. A notable feature of the formation is the greatly decomposed, semi angular pebbles of chert, feldspar, and other silico-aluminous minerals. These contribute largely to the mottled appearance of sections, and are sometimes of sufficiently large deposits to be of economic importance. While their decomposition has unquestionably continued since deposition in their

*"Reconstruction of the Antillean Continent."—J. W. Spencer.

present position, it is quite probable they were in a high state of disintegration before removal from their parent source.

BRIEF HISTORY OF THE COLUMBIA FORMATION.

The geologic position of this formation is above and contiguous to the Lafayette, upon which it rests uncomformably. Its age is almost certainly Pleistocene Quatenary.

Though in its upper members, the brownish-yellow clayey loam and loess, extending over the hills of most of the area of the Lafayette, in the main it is a valley and low level deposit, which partially fills the deeply excavated valleys of the Lafayette erosion, and laps upon the slopes of its thousand hills.

With the retreat of the axis of oscillation southward during the closing stages of the Lafayette, when the continent was reaching its greatest altitude, the materials from the eroded Lafayette and other formations began to be deposited upon the yet rising slopes of the Lafayette.

In Louisiana these materials constitute the basal pebble and gravel bed of the Columbia formation.

While the continent stood at this great altitude, which enabled the enormously more active streams to cut deep and wide their old channels, it is probable that the ice of the Glacial period accumulated, and inaugurated the continental subsidence which succeeded that period. At any rate subsidence began, and during the remainder of the Columbian period its sediments appear to have been deposited upon a *sinking* bottom.

The streams, though weakened by reason of decrease of slope, seem to have been greatly strengthened in volume from the melting ice in the North, and their waters came sediment-laden with the rock flour of the glacial mill. This sediment, mixed with the finer materials furnished by local land areas rapidly silted up the lower stream beds, and the materials deposited at their mouths were distributed by the waves and currents along the shore, forming a broad, submarine terrace.

In this we have the Port Hudson group of clays and the broad stretches of "pine flats" in their greater part.

With further subsidence and submergence of local land

areas, local supply of materials was greatly diminished, and only "rock flour" from the glacier region, and materials from the upper courses of the now sluggish streams were furnished. These form the brownish-yellow clayey loam and loess, the upper member of the Columbia formation.

These in varying proportions and relative positions, showing their contemporaneous origin, form the surface deposits over the region described, save in the river bottoms where the deposits are annually forming over the flood plains of the streams.

The volume of the upper Columbia deposits seem to have been a function of the vigor of the producing streams; and as local supply was reduced, only the Mississippi seems to have been effective in producing the final upper member, the loess, of the region.

This deposit of glacial materials, collected by the great northern branches of the Mississippi, which sent their feeders into the glacial field of Northern United States, was formed as a broad natural levee upon the submerged banks of that stream. This is the so-called "bluff" of West Feliciana, East Baton Rouge and Livingston parishes.

The "bluff" is absent from the banks of the Amite, Tangipahoa and Pearl, for the reason that these streams did not have their headwaters in glaciated regions; or at any rate not in regions of the great continental ice sheet which furnished these deposits to the Mississippi.

That the axis of oscillation still remained far to the south during all this period of subsidence is indicated by the deeply drowned valleys in the West Indies made in Lafayette deposits.

Characteristic of the upper members of this formation are the *vertical walls* and steep slopes where erosion occurs. These remain for long periods without crumbling, probably owing to the fine grained, homogeneous character of the deposit. Though yielding readily to the action of sediment-charged flowing streams, the ordinary processes of weathering are very slow.

McGee says of this "loess" deposit: "As usual it displays the paradox of friability so perfect that it may be impressed by the fingers, combined with obduracy so great that it

stands in vertical cliffs for a decade without even losing the marks of spade and pick."

This of course only in the Southern section of this deposit where frost is seldom formed.

The Columbia formation thus presents four distinct phases:

1. The *basal gravel* deposited upon and contiguous to the capping conglomerate of the Lafayette as subsidence began and the sea began to encroach upon the land; and when the continent still stood at a great altitude.

2. The *Port Hudson clays*, a valley and low level deposit upon the still subsiding Lafayette, which clogged the rivers and spread along the coast producing the broad flats.

3. The *brown loam* which mantled both hills and valleys when continued subsidence brought them below sea level.

4. The "loess" proper or "*bluff*," a product of the Mississippi river, the materials of which were obtained almost entirely from the glaciated region to the far North.

While these various deposits are characteristic phases of a practically continuous deposit, there exist, locally, deposits of gravel, sand, and clay derived locally from Lafayette strata and hardly distinguishable from it. The influence of local supply is best seen along the margin of the Lafayette hills. The basal gravel of the formation except along the larger streams, is plainly local, or at least not far travelled; whereas the later members were increasingly foreign in the origin of their materials.

Southwest Louisiana, excepting a few very limited and detached areas, belongs like the Florida parishes to the Lafayette and Columbia formations. While just north of this region outcrops of the underlying Grand Gulf formation are found; and extending through it in a northwest and southeast direction, from Belle Isle in the southeast to Chicot in the northwest, is what has been termed a "Cretaceous backbone," these formations are on the whole so deeply covered by Quaternary sediments as to exercise little or no influence upon either topography or soil.

While perhaps effective during Lafayette and earlier Co-

lumbia times in *directing* the courses of the sediment-bearing streams, this cretaceous ridge, if it existed, furnished little material for later deposits, and for the most part was in an attitude to receive sediments, even so large as coarse gravel and pebbles; as attested by the beds of that character found more than 150 feet above the gulf level on Petite Anse and others of the five islands.

Though of the same geological age as the surface formations of the Florida parishes, the difference in character of the soils is marked and distinctive. This difference is not one resulting from a difference in the attitude of the bottom receiving sediments, but rather a difference in source for these sediments.

Geologically this section offers little additional to the results obtained from a study of the Florida parishes. The "pine hills" are Lafayette clays and sands, of the prevailing red and yellow colors, and contain the same subangular cherty pebbles.

In Calcasieu as in St. Helena, wells are sunk to the basal gravel bed of the Lafayette which is found at depths varying with surface topography from 50 to 150 feet, and which always furnishes an excellent and unfailing supply of water. In such wells the upper, massive member of the Lafayette stands indefinitely without curbing, while the lower, sandier and stratified member requires to be curbed.

East and south these deposits sink beneath the prairies, and though too deeply buried to affect surface conditions may be found in Artesian wells.

The most southerly point at which these Lafayette sands and clays may be seen, is upon Belle Isle. This in common with the other four islands to the northwest, Cote Blanche, Grand Cote, Petite Anse and Orange, display Lafayette gravels and sandy clays in their sections, underlying later Columbia deposits; all of which show disturbance since their deposition. We will find, when we come to treat of these islands more in detail, that these sediments have probably been raised to their present height since the time of Columbia deposition, rather than deposited mantlewise over hills of cretaceous rock produced by differential erosion.

The origin of Lafayette materials was the local and not distant land areas to the north, and their carriers were probably streams of rapid and somewhat local development, rather than any of the present streams of the region.

There is a slight difference in the nature of the pebbles from those commonly found in the "pebble streams" of East Feliciana and St. Helena, that might suggest a slightly different source.

Common among the pebbles east of the Mississippi are cherty casts of palæozoic fossils; and similar fossiliferous pebbles have been found in Southwest Louisiana.

As the Mississippi river undoubtedly existed in Lafayette times, it seems hardly probable that any considerable quantity of pebbles were carried across this broad basin from the Northeast; and we are to seek the source of these materials in the older terranes west of the Mississippi rather than east of that stream.

No other present stream of the region seems to have existed in pre-Lafayette times.

The Red river, that plays so important a part in the recent development of topographic form in Western Louisiana is of post-Lafayette, and possibly of late Columbia origin; at any rate it cuts through all the deposits of both, and its valley deposits are later than the "loess."

The Columbia formation of Southwest Louisiana, while in general like that of the Florida Parishes, is not the latest deposit over most of the area over which it occurs.

The Port Hudson group is found in the substratum of clays in the pine flats, and at a greater depth beneath the prairies and coast marsh.

All artesian wells pass through it, and it has more than once been mistaken for the Lignitic Group. Only in the flats and along the margin of the prairies is it near enough to the surface to make its presence felt in the soil; but along the eastern border of the "bluff," as at New Iberia, its clays are worked for brick.

Where near enough to the surface to affect the soils, they are considered cold and unresponsive.

The brownish yellow, clayey loam is found over all the region south and east of the hills and flats and extending to Bayous Cocodrie, Cortableau and Teche; or over the distinctively prairie section of the State. Though not the surface deposit—and in that it differs from the similar deposit of the Florida Parishes—it lies near enough the surface to give character to the soil, and within reach of the plow.

It extends at a slightly increasing depth beneath the coastal marsh, and may be recognized in the banks of all rivers and bayous, as also in the deeper ditches artificially cut for embankment or drainage.

This stratum is rich in lime; and this has collected into irregular concretions that are similar in character and origin to the concretions found in the true loess. These are the "children of the loess" of the Germans, and they make this deposit easily recognizable wherever seen.

On either side of the Salt Mine Railroad where it crosses the marsh this concretionary stratum outcrops in the ditches; and in the ditches produced in building the embankments for irrigating canals east of Lake Arthur, and in grading the streets of Lake Charles, the same stratum is cut.

This deposit thickens toward the east, and is found in its greatest development and with its upper silt member along the zone extending southward from Washington, and overlooking in a scarp, the alluvial lands of the Mississippi and its tributary and accompanying streams.

This, together with a similar thickening of the same deposit of the Florida Parishes toward the Mississippi river, suggests very strongly that the upper members of the Columbia are the product of this stream.

That the broad valley between these eastern and western "bluff" deposits, now occupied by the Mississippi and Atchafalaya rivers, and a score or more of bayous, with their respective "bottoms" is the valley of the greater Columbia-producing Mississippi, seems highly probable.

The general parallelism of the erosion tattered remnants on the west side with the continuous scarp on the east; and the presence of the similar "loess" deposits in front grading rapidly into the yellow loamy clay farther back, both point to those as the probable riverward limits of this deposit.

That the main current of the greater Mississippi or the river in a more contracted form has at different times occupied various positions within this broad channel, is shown by the three distinct and deeply submerged channels* extending across the coastal shelf between Belle Isle and Lake Pontchartrain; made when the continent stood at a greater elevation.

The axis of oscillation during post-Columbia elevation seems to have been northwest and southeast; so that even after the Florida Parishes were raised above the gulf level, Southwest Louisiana continued to receive sediments, and the surface, chocolate colored loam, was deposited over the prairies and more thinly over the pine flats.

Probably at this time the principal current of the contracting Mississippi was directed against its western bank—not yet emerged—and the numerous coulees across the "bluff," south of Washington, were produced.

With continued elevation to the southwest, the Mississippi gradually shifted the current of its contracted volume toward the eastern bank, until it impinged against the "bluff" escarpment of the Florida Parishes.

To what extent the river, with its present volume, is able to shift its bed by reason of meanderings and cut-offs may be shown by lines drawn tangent to the outer bends of those abandoned sections, or "horse shoe" lakes.

These will show that the river with its present volume can never migrate far from its present position, unless aided by differential elevation of its banks; and therefore it has been shifted to the eastern side of its valley by such elevation.

Perhaps second only in importance to the withdrawal of the Mississippi as an active geological agent in Southwest Louisiana,

*See map accompanying Dr. J. W. Spencer's "Reconstruction of the Antillean Continent."

by elevation to the southwest and west, was the development of the Red river and its possible diversion from a southerly outlet into the gulf.

That the Red river has been at some time a much larger and more active stream is shown by its broad valley and the multitude of lakes in Northwest Louisiana produced in its sometime strong tributaries by clogging of the main valley.

Certain clays worked at Lake Charles, from a pit not far from the Calcasieu have suggested to me that possibly the earlier Red river might have found an outlet by way of the Boeuf and Lake Cocodrie into the gulf along the route of the Calcasieu. These clays are very like undoubted Red river clays, worked at Washington from the banks of the Cortableau.

With the elevation to the southwest the course of the Red river was changed (if indeed it had a southerly outlet) and a new channel was cut through the yellow loam deposits of the western escarpment of the Mississippi, and old abandoned channels of that stream, as the Teche and Atchafalaya were occupied. These streams give evidence of that occupancy in the veneering of their beds, especially the Teche, by a stratum of unquestioned Red river sediment. In times of excessive floods in the Red river, the surplus water found escape through the Vermilion and Mermentau which find their sources in the coulees of the prairies east and north. Both of these rivers display Red river sediments in their banks.

Even yet, during excessively high water in Red river, some of the overflow finds an outlet through Vermilion river.

With further elevation in the southwest, the Mississippi continued to shift eastward and the Red river northward, sweeping away as its channel migrated, the broad zone of yellow clayey loams of the Columbia, leaving only here and there, as in Northeast Rapides and Northwest Avoyelles, tattered remnants or "islands."

With the Red river as with the Mississippi, the shifting of the current seems to have been accompanied by a decrease in volume; and the supply of sediments, while lessened seems not to have kept pace with the decreasing volume, and there resulted

a clogging of the lower valleys with sediment—in the Mississippi chocolate colored, in the Red a bright vermilion.

It is this chocolate colored loam, supplied by the Mississippi and spread over a shallow marsh, that forms the surface layer of the prairies of Southwest Louisiana.

One of the effects of this clogging of the main valley of the Red river was the production of lakes at the mouths of its tributary branches. Such are Sabine lake, Black lake, Lake Bisteneau, Lake Bodcau, Bayou Pierre Lake and many others.

III. SOILS.

Soils are the residual product of the weathering of rocks. They may be produced where found, but more often are removed from their place of origin. The agents of removal are *gravity*, *wind* and *running water*.

Under the influence of gravity all soils *creep* down the slopes upon which they lie. This process goes on continuously as a result of variation in temperature, and is most pronounced in latitudes and regions where range of temperature is greatest. If frost is formed creeping is greatly accelerated.

In northern regions, mountainous or hilly regions, and regions of crystalline rocks this is an important factor in soil formation and soil removal.

The wind is likewise an active agent in soil removal, especially in those regions that have a distinctly dry season.

The power of the wind to lift and transport particles of considerable weight during storms, and especially whirling storms, is recognized by every one; and those who have seen the coarse sand of the northern lake beaches piled 200 feet high, overwhelming forests and villages, recognize in the straight, steady wind of considerable velocity an active and powerful transporting agent.

Pebbles upon the seabeach, worn by wind-driven sand into

angular and fantastic shapes illustrate the efficiency of the wind when surcharged with sediment, as an agent of erosion.

The custom in certain parts of the country of building residences and planting orchards upon the highways illustrates the forced recognition of the wind as a transporter of dust.

But it is from the wind swept prairies of the northwest, where during the frequent long droughts it is necessary to protect the cultivated lands from the denuding action of the winds by planting in narrow strips separated by strips of meadow turf, that we glean the most important lessons concerning the wind as a geological agent.

By far the most important agent in soil production, soil removal and distribution is running water.

Physical agencies combine with chemical to break down all surface rocks, and reduce them to a finely divided condition.

This weather rock is soil; and while in the main partaking of the parent rock, always loses something in solution and may likewise gain other elements during transportation and deposition.

According as soils are found where formed, or at most only slightly shifted by gravity and wind; or are transported by and deposited in running water, and hence show some degree of stratification, they are *colluvial* or *alluvial* soils.

The soils of our ridges and hill slopes belong to the former class, while our valley soils are alluvial. These groups are necessarily indistinctly separated, and all degrees of inter-gradation exist.

All soils may be considered as composed essentially of *sand clay* and *vegetable matter*; and the predominance of these elements respectively gives the classification of soils as *light* (sandy), *heavy* (clayey), and *humus*.

This classification, chiefly upon physical characters, is of the greatest importance, inasmuch as our treatment of any soil must be largely determined by our recognition of its belonging to one or the other of these groups.

While depth and character of any soil are largely affected by topography and climate, yet there are few *virgin* soils that

have not in them the necessary elements of plant food. We are chiefly concerned in knowing how to *preserve* and to *increase* their producing power.

Aside from the withdrawal of plant food by growing crops the chief loss of fertility in the soil is due to *leaching*, or the removal of elements of plant food by solution in water percolating through the soil. The lighter or more sandy the soil the greater the liability to leach.

On the other hand heavy or clayey soils are apt to be unproductive because of lack of drainage.

Whether decaying vegetable matter shall or shall not be a valuable element in the soil is also largely a question of drainage.

In wet, poorly drained land the result of decomposition is a brownish, partially soluble product that because of its acid qualities produces what is termed a *sour* soil which is unproductive.

In well drained land the decay of vegetable matter underground produces the black, insoluble *humus* universally recognized as giving fertility to the soil.

In the Florida parishes the three classes of soil mentioned are found over large areas.

From the nature of the deposit the greatest amount of humus is found in the soils of the river bottoms, especially the *first* bottoms, that are subject to overflow.

The "second bottoms" and "pine flats" while containing considerable amounts of humus are more especially characterized by the development of that distinctly clayey group of strata, the Port Hudson, which produces a heavy soil.

Moreover, much of the soluble plant food from the hill soils has been deposited there.

These all combine to make these soils inherently fertile or *strong*. This has long been recognized in the *modern* alluvial deposits over the flood plains of streams, but as yet unappreciated in the "flats" and "second bottoms" that constitute nearly one half of those parishes east of the Amite.

In their present undrained condition these soils are *sour* and unproductive. This can be completely corrected by *thorough*

drainage and some addition of lime to assist in changing the brown, soluble humus into the true black humus desired.

When this is done these lands will become among the most valuable in the State.

Over the hills of these parishes, east of the zone of "bluff" bordering the Mississippi river, is spread a thin coating of brownish yellow, clayey loam that is highly productive. Immediately underlying it at a depth varying from a few inches to a few feet is the much more sandy Lafayette; which, when it becomes the upper soil from removal of the yellow loam by erosion, loses its soluble plant food rapidly by leaching. Great care should therefore be exercised to preserve this protective coating from being removed by washing. This can be done by proper cultivation, and by resorting as much as possible to those crops that require the least stirring of the soil.

Cultivate the valleys, and reserve the steep slopes and ridges for pasture and meadow.

Throughout these parishes are found "old fields" aggregating thousands of acres, that were once productive, but lost their productiveness by inattention to this matter of preservation of the fertile, but easily removable coating of loam.

Along the banks overlooking the ancient Mississippi is found a soil, the loess or "bluff" which combines perhaps more of the elements of productiveness than any other soil in the State.

Being well above the flood plains of the streams it is easily drained; and containing much more of clay than sand it does not leach rapidly.

Rich in lime, humification, even in poorly drained areas, is rapid and of the desirable kind.

Yet, being so fine grained and incoherent, this deposit erodes rapidly, and the greatest care should be exercised to prevent this wastage by erosion.

Four classes of soils are then found in the Florida Parishes, corresponding to the three upper members of the Columbia formation, and the modern alluvial deposits in our river bottoms.

Each has its characteristic vegetation, which is probably in

part a result of the chemical composition, and in part of the physical consitution of the soil and underlying subsoil.

The alluvial soils of modern formation along the streams are characterized by hard wood, deciduous and evergreen trees, with a thick undergrowth of shrubs and vines.

The pine hills west of the Amite, the "good uplands" of Lockett's map, are clothed with short leaved pine, generously interspersed with magnolia, oak and beech.

East of that stream the prevailing growth upon the hills is long leaved pine with sparse undergrowth of black jack oak.

Toward the Mississippi river, as the yellow loam thickens the pine gradully gives place to hard wood, and within the zone on Lockett's map marked "bluff," entirely disappears.

The soil of the "pine hills" is shallow, and the closely underlying deposit is a semi-indurated clayey sand rock, that is very impervious to the roots of trees. Uprooted pines show their central roots twisted and gnarled into a knotty mass.

Whether from lack of proper food elements, or as seems equally probable, from insufficient anchorage against strong winds, heavy topped, hard wood trees are wanting.

Black jack, and a few other scrubby representatives of the oak family constitute the group of hard wood trees in this region.

The area is practically exclusively occupied by splendid forests of virgin pine.

The warm, responsive, well drained soil is ideal for pasturage.

The "flats" bordering the hills have essentially the same vegetation as the hills; but as we approach the sea marsh the live oak makes its appearance and becomes a characteristic member of the flora.

Here, too, as in the alluvial swamps, we find the stream margins afford abundant bay, gum and cypress.

The "bluff" is covered with forests of hardwood; beech, magnolia, oak and hickory are the families chiefly represented, with a dense undergrowth of cane, dogwood, holly and numerous species of the haw family.

The better drained alluvial lands have much the same character of forest as the "bluff," though gums are much more abundant; while the swampy bottoms are given over almost exclusively to willow, gum and cypress.

Upon certain sandy bottom lands, as islands in the streams and recently formed land on the inner curves of bends of rivers; as also in certain regions where by a break of a levee a stream has suddenly spread a thick coating of sand over the bottom, cottonwood is abundant.

We are thus almost able to classify the soils in the order of their desirability by the character of the virgin vegetation.

In Southwest Louisiana all the types of soil found in the Florida parishes are represented. The "bluff" and "pine hill" areas are the same in both regions, but the "flats" are modified by a thin surface layer of the chocolate colored silt that overspreads the prairies. The treatment of these soils and their adaptibilities are the same as their homologues east of the Mississippi.

The so called "good uplands" of the Felicianas, while they have no representative in the Southwest country, are but an intermediate grade between the "bluff" and the "pine hills" and therefore cannot be considered a type.

Differing from any soil described, however, and peculiar to the southwestern section of the State, are the soils of the prairies.

Excepting the Red river and more modern alluvium, these are the most recent deposits in the State. When the rest of the State was above the Gulf level, this region was still receiving a deposit of silt-like loam from the increasingly sluggish current of the Mississippi. This chocolate colored silt, spread upon a stratum of the calcareous yellowish brown loam, in an increasingly marshy area, has produced one of the mort fertile soils in Louisiana. The upper stratum of silt, varying from two or three inches to a foot in thickness, while producing excellently as a virgin soil, by reason of its light, porous character soon becomes exhausted. On this account many of these lands are held in low esteem.

There lies beneath, however, and within reach of the plow,

the elements lacking to make these selfsame soils fertile, strong and retentive. The concretionary clayey loam, that everywhere constitutes the subsoil, if mixed with the chocolate loams produces a soil that as Lockett has expressed it is "good enough."

The admixture of the clayey loam has a twofold effect: by adding *lime* to the silt humification is accelerated and a blacker, more desirable soil produced; and by increasing the *clay* constituent the soil is made more retentive of easily removable plant food.

The old idea that *any* soil is inexhaustible in its fertility has occasioned deterioration in much of the most productive land of the State that will require years to correct.

All soils are not only exhaustible, but as a rule rapidly so; and unless their productive power is fostered and their fertility constantly renewed even the most productive become worthless.

The "black prairies" of St. Landry and the Attakapas country owe their color to the fact that the silt covering is sufficiently attenuated to place the calcareous substratum within easy reach of the plow even in ordinary cultivation. All these silt covered prairies would become equally "black" and productive with a like mixture of the clayey, concretionary subsoil.

Along the coulees and bayous are certain black or grayish black, waxy lands known as "buckshot" lands. These are very productive when properly drained and worked in season, but are difficult to cultivate, requiring often specially adapted implements.

So far as superficial examination could settle the matter, these are of the nature of swamp deposits; and are forming in many swampy regions in the Mississippi bottoms of to-day.

The Port Hudson clays, where deposited with sufficient quantities of vegetable matter would produce just such soils. Some of these may indeed belong to this group, but most of them are swamp deposits of more recent date.

The prairies, where level and imperfectly drained, are treeless; but along the streams there is a luxuriant growth of timber.

Back near the remoter beginning of the streams, where the prairies become broken into knolls, as in the northern part of

"Prairie Mammou" and "Pine Prairie," the long leaved pine is gradually extending its dominion and occupying the region.

As we pass westward into the region of the mounds or "pimpled prairies," the soil becomes more and more sandy—the sand furnished by the mounds themselves.

This sandy soil is most excellently adapted to the production of small fruits, and many vegetables. Some of the most luscious pears and peaches I have eaten in Louisiana grew upon these "pimpled prairies;" and the splendid dewberries and blackberries that come spontaneously in neglected fields and by the roadside everywhere give ample proof of the suitability of the soil for this class of fruits.

Vegetables of the cucurbit family, as watermelons, muskmelons, cucumbers, etc., find here a most congenial home; and when more direct communication with northern markets is secured must become an important product of the region.

For the present these soils are very largely *compelled* to produce rice, though much better adapted to a score of other products.

In the regions of the bayous, *e. g.*, the Boeuf, the Cortableau and the Teche; and as we approach the coastal marsh, where the streams annually or periodically overflow their bottoms, there is always a marked difference in the "front" lands and "back" lands.

Both are the gift of the streams; but the front lands are coarser grained, sandier, and higher than those farther back. They form a broad, low natural levee upon either side of the stream and are always selected as residence sites, because better drained and healthier.

Before the State was divided into townships and sections, "grants" were laid off with so many *arpents* frontage upon these bayous and so many *arpents* deep. Upon the front lands the homes were built, and the back lands reserved entirely for cultivation.

This natural distribution of the sediments by a stream upon its flood plain is based upon their weight and size. The coarser, heavier particles are dropped where there is a maximum check-

ing of the current, *i. e.*, along its banks; and the finer loams and clays are carried to the quieter waters farther back. The soils of the "back" lands are therefore finer grained and more clayey, and at the same time less easily drained. Though of similar origin and but different phases of the same formation, these two classes of soils are as a rule so unlike as to require entirely different methods of cultivation.

The front lands are light, easily drained and responsive; the back lands heavy, wet and cold. The first consideration for these latter is thorough drainage; and this accomplished they prove the more fertile and enduring of the two.

IV. ECONOMIC PRODUCTS.

MINERAL PRODUCTS.

Few mineral products of economic value are found in the Florida Parishes.

Iron.—Capping the hills in the north, and immediately underlying the thin veneering of Columbia yellow loam, is a thin bedded ferruginous sand rock and conglomerate.

Though reported elsewhere in the coastal plain as of sufficient richness to be treated as an iron ore, nowhere in the Florida Parishes does this *ferruginous sandrock* or *arenaceous ironstone* occur either in sufficient quantities or rich enough in iron to be considered a valuable ore of iron.

The only use made of it, so far as observed, was as foundation stones for houses and fences; which purpose it serves excellently, being very durable and occurring in thin beds easily worked.

The iron concretions seen in road cuts, and often having the appearance of cannon balls and pots, while rich in iron, are only objects of curious interest and scientific value.

Clay.—Much the most important mineral product of these parishes is the extensive deposits of Columbian clays. These

exist throughout the flats and second bottoms of the streams. They are not the *typical* Port Hudson clays, which are too "fat" for manipulation by the ordinary methods used in the brick factories of this section, but a mixture of these with the later sandy loams that overspread their coastal representative and produced the flats and second bottoms of the larger streams.

Along the Illinois Central and Northeastern railroads through these clays, brick-yards have been established; and throughout the older settled parts of the pine flats, as in St. Tammany, evidences of *ante bellum* brick kilns are seen.

This deposit of clay, coextensive with the flats and second bottoms, is practically inexhaustible.

By the ordinary methods used to the depth of four to ten feet, many times that depth is available by processes that utilize clays now considered too fat.

The clays of the hills are as a rule too lean for brick making.

In the valleys of the smaller streams, *e. g.*, at Clinton, East Feliciana parish, the clay is of workable quality.

In the region of the "bluffs" it is only where this deposit is cut through and reveals the mixed loess and yellow clayey loam that brick manufacture is carried on.

The brick works at Baton Rouge are using this mixed product.

The extensive deposits of brick clay in the Florida Parishes which produces a most excellent quality of building and paving bricks, make the clay industry one of the most important industries of the near future.

Sand.—Though intimately intermixed with red clay, and loam, thus giving the impression that the red color of the sand is inherent, when washed by the streams the sand of the Lafayette group of strata collects in beautifully white banks, and may be used in building.

It is chiefly siliceous and retains a fair degree of sharpness.

Gravel.—Though not found in the extensive accumulations common farther north, yet along the old and modern waterways gravel and pebbles have been deposited in quantities sufficient to make them valuable as sources of ballast for railroads and highways.

In northern East and West Feliciana especially, were such gravel pits noted.

Marls and Phosphates.—In one or two instances reports of marl deposits came to me, but no such deposits were found. I think none of importance need be looked for in the Florida Parishes. The formations in which workable deposits of phosphates and marls occur in adjoining States lie considerably below any surface deposit in these parishes. The strata here are not to any extent fossil bearing, and though vertebrate remains are found in the valley deposits of the Columbia, it is probable that the decomposition of the organisms was extremely local in its effects.

The sedimentary strata are fragmental in character, and the sediments were borne by streams which, as a rule, did not flow through a limestone country. The "bluff" producing Mississippi is an exception, and in the "bluff" we find an abundance of the marl element finely divided and universally distributed.

Building Materials.—No beds of limestone or sandstone exist in this section of Louisiana.

The compact, upper member of the Lafayette, while presenting a glazed, rock like appearance in an exposed section, is far too friable and incoherent to be used in construction. The clays and sands are the only valuable mineral constructional materials.

Water.—The matter of water supply is one of the most important of economic questions to be considered in determining the desirability of any section for residence. In this the Florida Parishes are particularly blessed.

Throughout the hill region, the basal pebble bed of the Lafayette furnishes a never failing supply of clear and wholesome water.

Though impossible to secure accurate sections, as the well makers questioned had not been interested in preserving a record of materials passed through, yet it was the invariable rule to sink the well until the red mottled deposits of sand and clay were passed through and a bed of "white sand and pebbles" was reached.

Further sinking was said to "spoil the well," as it passed into a stratum of bluish clay, probably Grand Gulf, which taints the water.

Throughout the hill parishes of this section the wells vary in depth from 30 to 150 feet with the surface topography; thus indicating a comparatively regular and constant bed of basal gravel beneath the Lafayette sands. As no exact elevations were taken, the relation of this water bearing stratum of gravel to the beds of the larger streams cannot be definitely stated; though they do not differ greatly in elevation:

These are in no case Artesian wells. When they are *dug* wells only the lower part requires curbing, as the massive upper member of the Lafayette in the vertical walls of the shaft becomes glazed and hardened, and stands indefinitely without caving.

Waterbearing strata are found in the Lafayette above the basal gravel, but the flow in wells remains so long discolored by the ferruginous clays that wells are rarely stopped short of the basal gravel, and higher water supplies are curbed out.

These upper water bearing strata, by their outcrops furnish the numerous springs at the bases of the hills along the secondary valleys. Numerous spring branches are thus supplied throughout the year with most wholesome crystal clear water.

Only one Artesian well in this section is known to me; this is at Baker, on the Yazoo & Mississippi Valley Railroad, about seven miles above Baton Rouge. This well, which is something over 700 feet deep, rises in a stand pipe twenty or thirty feet above the surface of the ground. The water is pure and palatable.

The same water bearing stratum was struck in a well of the Water Works Company in Baton Rouge, at a little less than 800 feet, but this well is not Artesian, probably because the higher water bearing strata which were not curbed out act as drains upon rather than contributors to the deeper supply.

A new well is being sunk near the old, and it is the intention to exclude all but the deep supply, and a flowing well is confidently expected.

In the "flats" wells sunk to the basal gravels of the Lafayette become flowing wells. In many instances, however, deeper boring has discovered stronger flowing streams of better water.

The mineral wells about Covington, in St. Tammany parish, are of this deeper class.

Many of these Artesian wells have valuable medicinal qualities, and hundreds of people go annually to test their healing properties. When better known they will probably become favorite health resorts for the thousands who now go to other wells and springs.

Abita Springs, in St. Tammany parish, are already well and favorably known.

Few of these Artesian wells have been analyzed. The following is an analysis of Abita Springs water, made by A. L. Metz, Ph. G., of New Orleans. The analysis gives the *number of grains in a United States gallon:*

Sodium Chloride	1.473
Sodium Carbonate	1.294
Magnesium Bicarbonate	3.946
Calcium Bicarbonate	3.084
Ferrous Bicarbonate	1.303
Calcium Sulphate	5.122
Potassa	0.201
Alumina	0.109
Silica	1.075
Organic Matter	1.347
Total	18 854

Mr. Metz says: "The above results show that the water is of superior quality from a sanitary and hygienic point of view."

An analysis of the Roche well at Covington, St. Tammany parish, made by the same chemist, but expressed in *parts in one thousand,* is as follows:

Sodium Chloride	.0842
Sodium Carbonate	.0249
Magnesium Bicarbonate	.0692
Calcium Bicarbonate	.2802
Ferrous Bicarbonate	.1418
Calcium Sulphate	.0716
Ferric Oxide	.0759
Aluminum Oxide	.0879
Potassium Silicate	.0999
Silica	.3637
Organic Matter	.0760
Total	1.3753

An Artesian well belonging to Mr. Charles Thiery, near Covington, is 400 feet deep, and flows with such force as to furnish power for running fans in his hotel. Mr. Thiery thinks the water would rise 100 feet above the surface of the ground.

At Summer Camp Farm, on Bogue Falaya river, two and one half miles north of Covington, Mr. W. H. Ellermann has an artesian well 410 feet deep, from which the water rises about 30 feet and flows 55 to 60 gallons a minute through a 1¼ inch pipe. This measured flow, the result of many measurements, is found by Mr. Ellermann to vary with the phase of the moon ; being 5 gallons greater when the moon is young than a week earlier or later.

On Millhaven Farm, north of Covington, are two Artesian wells ; one 425 feet deep, flowing about 90 gallons a minute through a 2½ inch pipe, and the other 375 feet deep, furnishing 100 gallons a minute through a 2 inch pipe.

In and around Hammond are numerous Artesian wells, which vary in depth from 40 to 300 feet, the deeper passing through several water bearing strata.

As a rule here the deeper the well the stronger the flow.

At from 75 to 125 feet below the surface a stratum of organic matter is here passed through, and the flow brings up fragments of wood, bark and cones of pine.

No well reported here that raises water more than 20 feet above the surface of ground.

Southwest Louisiana, while in no sense a mineral section, is pre eminently the most important mineral section of the State.

What has been said of the mineral products of the various formations in the Florida Parishes may be equally well said of the corresponding formations here.

Clay.—In addition to the Columbia clays described on previous pages there is worked at Washington and New Iberia clays of most excellent quality and of later deposit. These are clays of Red river origin.

No analyses of these clays have yet been made, nor have the manufactured products—bricks and tiles—so far as I know been tested as to strength, etc. These are lines of investigation mapped out for the future.

Gravel.—In the hills "streams" of gravel similar to those mentioned in the Felicianas are found; but so far as learned only one such accumulation is exploited. In the hills of southern Rapides, east of the Kansas City, Watkins and Gulf Railroad, immense quantities of gravel are obtained for road ballast.

With further development of the region these excellent deposits of road metal will be appreciated and in greater demand.

Building Stones.—In Northwestern St. Landry is found a very limited area and inferior quality of limestone. Though Dr. Hopkins says of this deposit that it can supply "lime and building stone for the State," my examination of the deposit leads me to believe that it is not sufficient either in quantity or quality to be of much economic value.

While under the pressure of necessity lime has been manufactured from it, I could find no evidence that it had ever been otherwise used as a constructional material. Indeed it contains a fatal weakness, as a building stone, in the abundance of iron pyrites whose crystals glisten upon every broken surface.

Dr. Hopkins* describes it as "a grey limestone of good quality for burning into lime, and of sufficient hardness to be used as a building stone. It occurs in a hill of drift, on the territory of the Grand Gulf strata. The drift clay has to be removed in order to expose the stone, which has been quarried to some extent, during the war, for lime. The stone is of the variety known as anthraconite, from its giving a foetid odor when struck. Parts of it are studded with minute crystals of iron pyrites, while others contain natural fissures, whose sides glitter with cale spar. This quarry will prove a valuable property on the opening of railroads in the vicinity. At present the expense of transportation is too great to allow of successful competition with the West, in supplying our State with lime and building stone."

This stone is believed by Dr. Hopkins to be of Cretaceous age, though in the absence of fossils it is impossible definitely to classify it. It is in the line of the "Cretaceous backbone" of

*First Annual Report of the Louisiana State Geological Survey, 1869. —By F. V. Hopkins, M. D.

the State, and is undoubtedly older than the Lafayette. Its fissured condition, wherever observed, either in outcrop or from Artesian borings, shows that it has been subjected to considerable strains, that have not only shattered it, but have produced slight metamorphism—shown by its compact nature and semi-crystalline character.

In a ravine on Petite Anse is exposed a thin bed of slightly metamorphic sandrock, which is probably Grand Gulf, and which, if in sufficient quantity, and not too deeply buried beneath Lafayette sands and gravels and Columbia loams, would make a good constructional stone.

There is great demand for quarries of building stone in this section, not only for the ordinary uses in houses, culverts and bridges, but by the government in its efforts to secure deep water at the mouths of the Sabine, Calcasieu and other rivers. So far the search has proved and is likely to prove fruitless.

Water.—No single feature is more strongly impressed upon the notice of one passing from the hills to the lowlands of Southwest Louisiana than the character of the water supply.

In the hills one sees everywhere springs and spring creeks supplied from the sand strata of the Lafayette, and the supply of drinking water is obtained by rich and poor alike from wells dug or bored to the basal gravels of the Lafayette. As east of the Mississippi this is an unfailing source of pure and wholesome water.

In the flats and the prairies, as in the alluvial regions, the main supply of drinking water is from accumulated rainfall stored in casks and overground cisterns.

The wealthier class of these sections have Artesian wells, that may be had anywhere for the boring, and if sunk to sufficient depth furnish excellent water. Many of the larger sugar plantations obtain their chief supply of water from this source.

There are few "mineral springs" in this part of the State. The only springs that have attracted sufficient notice to become a "resort" are the Belle Chaney springs in northern St. Landry parish.

In the alluvial flat in the bottom of Vermilion river, east of

Lafayette, is a large and locally well known chalybeate spring, that has by its overflow built up around itself a broad, basin-like rim of iron.

In the vicinity of the sulphur mine are numerous springs with varying mineral properties. One of the most remarkable of these is the so called "sour" spring; which probably owes its acidity to a small percentage of sulphuric acid.

Precisely similar "sour" springs are found upon Belle Isle; and as this is thought to be a geologically similar region to the underlying sulphur bearing rocks of Calcasieu, and as here as there gas and oil escape in the surrounding marsh, it may be that similar mineral deposits will here be found.

All of the five "islands" have an abundance of excellent spring water, from Lafayette sands.

Salt.—By far the most unique and probably the most important mineral product of Louisiana is the deposit of *rock salt* known to exist upon Petite Anse and Orange Islands, and in all probability upon Grand Cote, Cote Blanche and Belle Isle as well; as also beneath the intermediate marshes.

These salt deposits, supposed to be cretaceous in age, are at the southern extremity of the socalled "cretaceous backbone of the State.

For a long time salt springs have been known to issue along this line, as the names "Saline Bayou" and "Saline Lake" attest, and old abandoned saltworks in the northern part of the State show that at an early date in the history of Louisiana salt manufactured from these springs and wells became a commercial product.

But it was only during the Civil War that the deposit on Petite Anse was discovered, and in 1894 or 1895 that a like discovery was made upon Orange Island.

At Petite Anse salt has been for years extensively mined; and a cave in one section of the mine shows the rock salt lying within fifteen feet of the surface and directly overlain by Lafayette gravels.

In another part of this island the salt deposit has been penetrated to a depth of 1000 feet without reaching the bottom; and

at Orange Island recent reports from Capt. A. F. Lucas (in charge at Petite Anse) show a continuous bed of rock salt penetrated for 1800 feet without passing through it.

Such thickness of rock salt is known nowhere else in the United States, and but few places in the world.

If, as is generally assumed, this immense thickness is the result of evaporation of a land locked sea, its continuity and purity proclaim a *constancy* of conditions that subsequent frequent and profound oscillations of the region discredit.

Analyses of the rock salt from Petite Anse show it to be almost 99 per cent. pure; and it is difficult to imagine a constant supply of sea water during the accumulation of more than 1000 feet of salt, without any admixture of mechanical sediments or other impurities.

It is such immense deposits of salt that make us doubtful of the sufficiency of the generally accepted theory of evaporation of land locked seas to account for them, and feel that we must find for them another explanation.

Concerning the *age* of the Petite Anse deposit, Hilgard* writes as follows: "It remains to be shown that the rock salt mass may, with a considerable degree of probability be claimed as a cretaceous outlier; and reasoning by exclusion, I think this can be done, by considering successively the formations to which it might be referred."

"Since the lowest (clay and pebble) strata of the stratified drift† are found overlying the rock salt mass, its age is at once removed beyond the limits of the Quaternary period."

"As regards the Grand Gulf group, though much impregnated with salts of various kinds, its general character as a fresh or brackish water formation renders it peculiarly ill adapted to the genesis of rock salt deposits. It is, moreover, a very predominantly littoral formation, whose deep water equivalents appear to be so thin that the drift currents have in most cases destroyed them. They have not been found in any bore near the coast.

*"Geology of Lower Louisiana and the Salt Deposit on Petite Anse Island." Smithsonian Contributions to Knowledge.—E. W. Hilgard, Ph. D.

†Lafayette.

"The Vicksburg rocks even (which are thinner and of less resisting material in Louisiana than in Mississippi) have been removed in a great measure by the drift, which in Calcasieu seems to be immediately underlaid by the Jackson group of the Eocene.

"But the marine groups of the older Eocene are of such inconsiderable thickness, each so variable in its nature, and so scantily supplied with salt, that to attribute to either of them the formation of so large and pure a mass of rock salt, seems to involve an utter incongruity.

"Not so with the Cretaceous formation that underlies them. Not only is salt water the invariable feature of the Cretaceous outcrops of North Louisiana, * * * , but it is there accompanied by that almost necessary complement, gypsum, which thickens to the southward, until, as demonstrated by the Calcasieu bores, it passes beneath the gulf with the surprising thickness of over six hundred feet.

"It is well known that the end of the Cretaceous period on this continent was characterized by a 'wholesale' conversion of ocean into inland lakes and dry land. What was, at that time, the condition of the Mexican Gulf basin, we have not the data to determine. But inasmuch as even in early Eocene times water connection still existed between the interior and the gulf; so of course the same must have been true of the Cretaceous inland sea, which by a continuance of elevation inland, was gradually receding toward the Gulf.

"The existence of the great gypsum formation, both in the interior and beneath the Gulf, argues the concentration and evaporation of a vast amount of sea water as a consequence of the general emergence; and it is but reasonable that the other chief ingredient—salt—should be found somewhere in connection with the great gypsum beds. And the great rock salt bed of Petite Anse, now known to exeeed seventy* feet in thickness, without such change of character, as must characterize any deposit formed on a small scale, seems a fit counterpart to the great gypsum bed of Calcasieu, with which the general dip of the formation would naturally connect it."

*Now known to exceed 1000 feet in thickness.

Sulphur.—In Southwest Calcasieu parish, about nine miles west of Lake Charles, are known to exist considerable deposits of sulphur. For a long time before any explorations were made, gas was observed to escape in bubbles through the boggy marsh and in certain places globules of oil could be seen rising and rapidly spreading over the surface of the pools.

This led to borings being made in search of marketable quantities of these two minerals.

Though the search in this direction proved fruitless—no gas being obtained and oil only in such limited quantities as to be of merely local value—yet it was discovered that beneath the region existed enormous deposits of sulphur.

Rich stock companies were formed and expensive machinery imported with a view to mining the sulphur; but misfortune followed so close upon the inauguration of every enterprise looking to the development of these mines, that though more than 30 years have elapsed since the first discovery of sulphur here, its successful extraction may be said to be yet in the experimental stage.

It is thought that a process has been discovered by which the sulphur may be easily and cheaply obtained, and in the *experiment* the new process proved *very* successful. Beautiful specimens of almost pure sulphur were presented to the Survey by the superintendent, Mr. J. C. Hoffman, and a considerable mass was displayed as the product of the initial run.

The principle involved in the new method is to force superheated steam by one pipe down into the deposit, which melts the sulphur and forces it up by another pipe. The principle and method seem both simple and rational; but certain difficulties were revealed by the experimental test, that had not been corrected when I visited the mine in the summer of 1895.

The following section furnished me by Mr. Hoffman from a bore 540 feet deep will give a very good general notion of the strata overlying the sulphur, and of the probable *age* of the deposit:

(1)	Yellow and blue clay	80	feet	Columbia.
(2)	Blue clay and fine sand	55	"	
(3)	Blue clay, hard and almost pure, with many sandy pockets	30	"	
(4)	Fine gray sand, water bearing	135	"	
(5)	Gravelly sand, increasing in size	45	"	Lafayette.
(6)	Gray sand, coarse	10	"	
(7)	Marl	2½	"	Grand Gulf, or Vicksburg.
	(Petroleum and Tar.)			
(8)	Blue sandy limestone	30½	"	
(9)	Calcareous marl	4	"	
(10)	Hard, rough, gray calcareous marl	5	"	
(11)	White saccharoidal calcareous marl	10	"	
(12)	White saccharoidal calcareous marl reduced to sand.	7	"	
(13)	Hard, compact limestone	25	"	Cretaceous.
(14)	Sulphur	112	"	

The upper yellow member of No. 1 is the attenuated stratum of yellow clayey loams; while the "blue clays" of 1, 2 and 3 are probably Port Hudson. No. 4 is probably the basal member of the Columbia and derived chiefly from the sandy clays of the Lafayette. Nos. 5 and 6 are pretty surely Lafayette. The next 60 feet are not so certainly identified, but in the main very nearly resemble the only Grand Gulf outcrops I have examined, in northern Vernon and southern Natchitoches parishes. They may be partly Vicksburg. No. 13 I have called Cretaceous because of its resemblance to St. Landry limestone.

In five other bores the bottom of the sulphur was reached at: 552, 621, 603, 593, and 568 feet respectively.

The following is the section of a well here, taken from Dr. Hopkins' First Report:

(1)	Blue clay, layers of sand	160	feet	—Prairie Diluvium.
(2)	Sand	173	"	—Drift.
(3)	Clay rock, soapstone	10	"	—Grand Gulf.
(4)	Blue anthraconitic limestone, fissured	40	"	—Vicksburg.
(5)	Gray limestone	60	"	Cretaceous.
(6)	Pure crystalline sulphur	100	"	
(7)	Gypsum with sulphur	137	"	
(8)	Sulphur	10	"	
(9)	Gypsum, grayish blue	540	"	

"The first four strata were all more or less oil bearing. Several streams of water were struck, one below No. 4 and the other below No. 5. The latter was a strong solution of sulphide of hydrogen, and was flowing during my visit, killing all the vegetation that its water reached. Stratum No. 4 is the one that seems to me to be identical with that of Chicot."

No. 1 corresponds to the *Columbia* of my section, and No. 2 to my *Lafayette*. No. 4, while pronounced here as *Vicksburg*, is recognized as similar to the St. Landry limestone, and Dr. Hopkins, in his Second Report classifies that as Cretaceous. With these amendations it will be seen that the records are fairly agreeable.

Concerning the origin of the sulphur here little is known. Being far removed from any volcanic outburst, we can hardly attribute its origin to volcanic agencies.

There have been unquestionable convulsions of the earth in this and neighboring regions in Southwest Louisiana that have fissured and to some extent metamorphosed the rocks; but it seems that these were more probably attendant phenomena upon the formation of the sulphur bed than results of volcanic activity.

The following, extracted from Dr. Hopkins' first report, for want of a more plausible one, is here offered as a probable explanation of the sulpur deposits in Calcasieu parish:

"The sulphur is of unequaled thickness and purity, and the gypsum is also of unusual quantity. Above them we have the remarkable fact of newer Tertiary and post-Tertiary strata, full of petroleum. Southern California and Trinidad furnish examples of oil from the Tertiary series, but here the drift and diluvium seem equally full."

"Dufrenoy states that sulphur is commonly associated with gypsum, rock salt and bituminous strata; and that in fact it is formed from the gypsum by deoxidation by organic matter.

"Whether the organic matter is of vegetable or animal origin is a debatable question. Either source would supply carbon and hydrogen, to remove the oxygen from the gypsum on the one hand, and to furnish petroleum and marsh gas on the other.

In this instance the large amount of sulphur produced points to the vegetable kingdom as the probable source; for the accumulation of animal matter sufficient for the purpose at this one spot, would have been an unexampled occurrence.

"The reaction between lignite and gypsum is very compli-

cated in nature, but may be thus approximately expressed:

$C_{12}H_{12}O_4 + 4\,Ca\,S\,O_4 = 4\,Ca\,C\,O_3 + 4\,S + 4\,C\,O_2 + 2\,C\,H_4 + 2\,C\,H_2$. Or, one equivalent of lignite, and four of gypsum give four each of limestone, sulphur and carbonic acid, with two each of marsh gas and olefiant gas.

"Now marsh gas and carbonic acid gas often issue from earth containing decomposing vegetable matter alone, but olefiant gas seldom or never.

"By a further reaction with marsh gas and water the olefiant gas becomes equivalent to petroleum, thus:

$32\,C\,H_2 + C\,H_4 + 2\,H_2\,O = 3\,(C_6\,H_{14}) + C_8\,H_{18} + \frac{1}{2}\,(C_{12}H_{24}) + C\,O_2$. Or, thirty two equivalents of olefiant gas, and one of marsh gas with two of water, contain the elements of one of petroleum, and one of carbonic acid gas."

"The sulphur was formed by reducing the gypsum with vegetable matter. The carbonic acid, olefiant gas and marsh gas produced by the process, have each left the appropriate proof of its presence, *i. e.*, the limestone stratum No. 5 contains the former, the petroleum is made of the olefiant gas, and the mounds were the vent holes for the latter."

Petroleum and Gas.—As already stated, the sulphur was discovered in the search for petroleum and gas. In all the marshy region round about the sulphur mine evidences of both these minerals are seen. The clays and loams of the Columbia and gravel and sand beds of the Lafayette seem to be impregnated with them. Wells stopped in these deposits, while furnishing fairly good water for a time, eventually become foul with crude oil and have to be abandoned. As far west as Vinton, in the Sabine Prairie, this was found to be so.

In the edge of the marsh east of Belle Isle numerous gas springs occur, and in several places pools of oil collect, in every respect like the gas and oil springs of Calcasieu. It remains to be proven if here too sulphur may be found.

Economically, these flows of gas and petroleum are of no value, and are only useful as probable indicators of the existence of other valuable mineral deposits.

VEGETABLE PRODUCTS.

With variation in the soil of any section goes always a corresponding variation in its vegetable products. Each plant requires its peculiar soil and climate.

As almost every type of soil is found in the Florida parishes, it is not surprising that we find there a wide range in the variety of vegetation.

Lumber.—Most of the region is or has been forest clad, and the source of vast quantities of pine and some hard wood lumber.

East of the Amite river long leaved pine (Pinus Australis) prevails; and the forests of this wood have long been an important source of revenue to the owners situated near a stream or railroad. In the hills thousands of acres of virgin pine of the very best quality yet remain. In the pine flats, especially of St. Tammany, numerous turpentine orchards are worked, and large quantities of turpentine and rosin are exported.

This has practically ruined these orchards for future sources of lumber, as large and small trees have been bled indiscriminately, and it will be many years before a new growth of this timber can be produced, if indeed, it ever can.

It seems to be the general experience that when the long leaved pine is entirely destroyed from any considerable area, it does not again spring up naturally, but is succeeded by the "old field" or loblolly pine (P. tæda) which is worthless for lumber.

By a judicious selsction of mature trees, and preservation of the vigorous young growth of the long leaved pine, splendid forests of this invaluable timber may perpetually furnish good supplies of lumber from both hills and flats.

The hills west of the Amite, with two or three small areas near that stream excepted, have only short leaved pine of an inferior grade for lumber. Toward the Mississippi, in the region occupied by the "bluff," the pine entirely disappears, being replaced by beech, magnolia, oak, hickory, ash, pecan and gum, which furnish limited quantities of hard wood lumber.

The alluvial bottoms of all the streams in these parishes likewise furnish small amounts of hard wood lumber, and the

swamps important quantities of cypress and cottonwood.

Southwest Louisiana offers nothing new in the line of lumber. The hills and flats furnish enormous quantities of long leaved pine, and the alluvial bottom lands an abundance of cypress and much oak and ash.

The lumber industry is the principal industry of these regions. The Calcasieu and its tributaries are filled with rafts of logs for the score or more mills upon their banks; and many miles of tram road are built to bring logs from the interior. At present most of the lumber is shipped away for manufacture, though factories are beginning to seek these lumber centers.

When this more rational plan of manufacturing the lumber where produced is more generally adopted, this section will have an era of prosperity before unknown.

Rosin and Turpentine.—An industry that has obtained some footing in St. Tammany parish only, so far as I have been able to learn, is the manufacture of rosin and turpentine. Several extensive orchards are worked east and north of Covington in the long leaved pine flats. This pine is exceedingly "fat" and produces well for three years.

If only trees large enough for lumber were bled for turpentine, both this industry and the lumber industry might be perpetuated in these flats and in the hills indefinitely; for bleeding a mature tree does not materially damage it for lumber.

But the vandalism practiced in these orchards in bleeding half mature trees yields but slight returns and perpetually blights the young forest, thus destroying the lumber industry for the future.

Charcoal.—In St. Tammany small amounts of charcoal are burned, but the industry has not assumed as yet any considerable proportions. It is here made from the long leaved pine.

Fruits and Flowers.—The hard wood areas furnish abundant beech and oak mast, and pecans in considerable variety grow naturally. Persimmons of several varieties are found native; and muscadines (Vitis vulpina) and two or three less important varieties of grapes are found in the alluvial regions.

One or two edible varieties of wild plum, and several va-

rieties of blackberries and dewberries are found. Papaws occur but scantily, and do not attain the tree-like size which characterize them further north. Maypops are abundant everywhere.

As to the cultivated fruits we are but beginning to realize the advantages offered by this section of the State for their culture.

Oranges have long been successfully grown, but the adaptability of our soil and climate to the growth of pears, peaches, (?) plums, persimmons and a long list of Japanese fruits; to strawberries and blackberries and the whole category of garden vegetables is only beginning to be appreciated.

Japanese fruits, flowers and vegetables seem to find a congenial home in the Florida parishes.

The sandy soils of the Lafayette hills are well suited to grape culture; and while imported varieties of grapes require much attention to preserve them against fungous diseases, yet there is found native in this region a grape, the muscadine, which with culture, I think bids fair to make these lands much sought after for vineyards.

This grape and its near kinsman, the scuppernong, seem to possess immunity from the diseases that prey upon imported varieties; and while not of value as table grapes produce wines pronounced by connoisseurs to possess a bouquet equal to the Italian and French wines.

Wines for domestic use are made by many from these grapes obtained from the open woodland; but so far as known to me no attempt has been made in the state to grow these grapes for the manufacture of wines for the market.

It seems to me to be a field as inviting as it is unoccupied.

Probably no other region in the United States is known where climate and soil so conspire to produce variety of flowering and decorative shrubs and trees as does the "bluff" section of these parishes. Magnolias of half a dozen varieties; camellias in variety more than a score; sweet olive, dogwood, holly, spirea, Cape jessamines, crepe myrtle; numerous species of the honey suckle family; oleanders and roses in infinite variety and profusion.

Probably no other flower or plant is more distinctive of these bluff lands, and certainly none more beautiful, than the tangled clumps and dense hedges of Cherokee rose. With its broad spreading white petals, and mass of yellow stamens it is easily the superior in perfection and beauty of any other rose, wild or cultivated, it has been my pleasure to see. One is surprised and disappointed, however, to find with all its exquisite beauty it is devoid of odor. The Cherokee rose is ever the exponent of a warm, fertile, responsive soil.

Growing profusely throughout the section, it is rarely or never cultivated as an ornamental shrub; but because of its vigorous growth, and sharp, strong, recurving thorns is much used as hedges.

An equally characteristic flowering plant of the "good uplands," extending also into the "bluff" region, is the fragrant yellow jessamine. With its long trailing branches, overrunning the fences, and climbing even into the low branching trees, it produces a carpet of yellow, which puts to shame any artificial "Field of Gold," and makes the early spring breezes heavy with its fragrant sweetness.

The plant, however, is considered a pest to be exterminated or at least confined to legitimate bounds as a decorative plant; inasmuch as it not only is not a forage plant, but chokes out the better grasses and occupies the land with its mat of twining branches.

It contains a poisonous element, and is to some extent used in medicine.

This is but one of the multitude of yellow flowers found in the Florida parishes, and the prevalence of yellows among the flowers of every season cannot fail to attract the attention of one passing through the section.

While the variety of annual wild flowers is not so great as in more northern latitudes, probably because of the slight range of temperature, yet no season is without its characteristic wild flowers.

The flats both of these parishes and of Southwest Louisiana have not nearly so varied a flora as the uplands, and the flowering annuals are chiefly aquatic.

"Water lilies," "water hyacinths" and numerous varieties of iris make the lake margins, gum "swamps" and bayous of the coast marsh gorgeous; indeed in many places, *e. g.*, in Bayou Bon Fouca, Bayou Vincent and Bayou Liberty in St. Tammany it is difficult to prevent these aquatic plants from choking up the streams to the extent of stopping navigation.

Forage Plants.—Louisiana is fairly well off in the line of native forage crops. In the hills and flats, until within the past decade, the chief dependence for native forage plants was in crab grass (Panicum sanguinale) and two or three species of Paspalum, or carpet grass. The last only has been of much value in the hills, and while furnishing good pasturage does not attain sufficient height to be cut for hay.

The Panicums and Paspalums, in the low lands and flats, furnish excellent hay.

About ten years ago there was introduced into Louisiana a forage plant that has won for itself unstinted praise. This is the Lespedeza striata or Japan clover.

Introduced, probably by accident, it has taken such vigorons hold upon the soil, both hill and flat, that but for its so recent introduction one might believe it indigenous here. Though appearing late in the spring, and maturing and dying long before winter, during its stay it is the most important native forage crop of the hills and among the best in the lowlands. In addition to being an excellent crop for grazing it furnishes abundant crops of hay.

It is found throughout the hills and flats of the Florida Parishes and Southwest Louisiana.

Another native forage plant of the "piney" woods is the "Beggar tick" (Desmodium molle), which is held in considerable esteem.

Upon the "bluff" soils Bermuda grass is the best grazing grass, and the native cane here furnishes good winter and early spring forage.

The prairies of the Southwest produce a grass that, while inferior to the grasses above enumerated, furnishes good summer pasturage; while stock in the coast marsh find nutritious grass the year round.

In addition to the native forage crops described we have a long list of cultivated crops that furnish abundant forage the entire year.

Without attempting to describe them or even to enumerate them entirely or in the order of importance, the following may be named: Corn, oats, cane, sorghum, cow peas, alfalfa, clover and peanuts.

The last four of these, as also lespedeza, possessing the power of taking up free nitrogen from the air, are important also as fertilizers.

Money Crops.—For a long time, practically only three "money crops" have been grown in the Florida parishes; cotton on the uplands and hills, and rice and cane in the alluvial lands.

Until within recent years these crops have been so remunerative, that no thought was given to any other, and the economic system of the section has been organized and developed upon the production of these three crops as a basis.

Changed conditions have greatly decreased the remunerative returns from these crops, and from sheer force of necessity farmers and planters are beginning to turn their attention to other and varied crops.

This will surely prove to be a "blessing in disguise." As a "one idea" man is a narrow man, so a "one crop" section of country is bound to be narrowing and discriminating in tendency—constantly widening the gap between the owner and tiller of the soil.

Variety of crops means diversity of interests, which in turn means competition and development.

We will now find what our soils are best *suited* for, and not what they may be *made* to produce.

It has been thoroughly demonstrated that *corn* will make a good crop throughout these parishes, and with the forage crops before named will make the raising and preparing for the market of stock—sheep, hogs and cattle—profitable.

Experiment has shown the Lafayette lands of North Louisiana well adapted to the cultivation of *tobacco;* and as the hills

of East Eeliciana, St. Helena, Tangipahoa and Washington parishes are of similar deposits, why should not the farmers of these parishes find in this another money crop?

The "flats" of Southwest Louisiana have proven most excellent *rice* lands; and about Hammond flats of similar character and origin are found to be well adapted to the growth of strawberries and other small fruits, as also for a host of vegetables that find a ready sale in the early Northern markets.

Almost half of the area east of the Amite river is a similar deposit, and has precisely the same culture possibilities as those lands that have been tested. It only remains for men of enterprise to take hold of these lands that have been considered worthless, to convert them into the most profitable fruit and truck farms of the state. The soil, usually considered too wet and cold for profitable cultivation, is so only so long as it is undrained.

The "bluff" lands of the Florida parishes need no further experiment to show their capabilities of producing almost any crop suited to the climate of these parishes.

The experiment at Baton Rouge to test whether these lands are suited to the growth of a high grade cigar tobacco has proven very satisfactory and favorable; and it is probable that this will become a valuable addition to the money crops of this section.

Here, too, the experiment with that most promising of fibre plants, ramie, has shown these lands eminently suited to its growth; and when suitable machinery for the preparation of its fibre is perfected, will doubtless take an important place among our crops.

The suitability of these "bluff" lands for sugar cane is no longer a question of doubt, as our upland cane, while not yielding so large a tonnage as that from the alluvial lands, possesses a higher percentage of sugar.

About the same conditions obtain in Southwest Louisiana as those enumerated in the Florida Parishes. The large prairie section, being peculiar to this part of the State, presents to some extent peculiar conditions. In the better drained, eastern part,

variety of crops, in which corn, perhaps, holds the leading place, has long been the rule.

The flatter, western prairies have been so recently put in cultivation, and the mania for rice culture has been so general, that the culture possibilities of these lands have scarcely been tested. Where orchards have been planted, however, pears, plums and peaches (?) have been found to attain great perfection, and strawberries, dewberries and blackberries are certain and abundant crops.

The long list of vining fruits, *e. g.*, watermelons, muskmelons, cantaloupes, cucumbers, squashes, etc., wherever tried in these western prairies have shown wonderful adaptability to the soil; so also beans, peas, cabbages, tomatoes and potatoes.

As perhaps most universally grown both here and in the Florida Parishes, and suitable alike for human and animal food, should be mentioned the sweet potato.

Adapted especially to the sandy soils of the hills, and the sandy loams of the prairies, its yield is rich and sure.

Though visited at rare intervals by killing frosts, the southern coasts, especially the islands and chenieres, are sufficiently safe from these low temperatures to make them suited to the growth of semi-tropical fruits. Previous to the blighting "cold wave" of February, 1895, splendid orange orchards existed upon these islands and along the margins of the lower rivers. These orchards, though injured and in some cases killed, are being renewed, and will shortly be as productive as before.

Perhaps the surest and favorite fruit of the entire State is the fig. Grown alike on hill and in flat; on the bluff and in the alluvial bottom, and throughout the prairies, it has established its claim to supremacy among the fruits of the State.

Whether or not any or all of the crops mentioned, whether fruit or vegetable, shall become a "money" crop, depends upon the enterprise with which markets are obtained. Being products common to the entire South, home markets are not of primary importance. The profit will arise from the ability to place these products upon an *early* Northern market before the similar home grown crops are available.

Being so readily perishable, the first and chief consideration must be direct railroad communication with these markets. That obtained, the agricultural, horticultural and fructicultural possibilities of Southwest Louisiana can scarcely be foreshadowed.

V. CLIMATE.

Among the first questions to be considered in determining the desirability of any region is concerning its climate; and especially is this true of an agricultural region.

While no region is so inhospitable in climate as to be entirely uninhabitable, yet the question of soil is so intimately associated with that of climate that any agricultural report that omits a consideration of the climatic elements must be considered incomplete.

The questions of temperature, and especially *range* of temperature; of moisture and the distribution of precipitation throughout the year; of winds and their local and often violent manifestations in thunderstorms and tornadoes are of primary importance to the farmer and planter, inasmuch as they control not only seed time and harvest, but also the character of crop he may profitably raise.

Far too little importance has heretofore been attached to the careful study of these questions, and it is to be hoped that soon there may be voluntary stations established in every village. It is only by such multiplicity of observations, carried on for a long series of years, that the influence of local though limited water-bodies, timber-areas and topographic relief may be seen.

From a study of the weather charts, and much better from an examination of the records of the separate stations, some striking facts may be gleaned.

Though the section treated in this report covers less than

one degree of latitude, yet the northern portion records in some years ten degrees lower temperature than the southern; and the *range* of temperature for the former is frequently fifteen degrees greater than for the latter.

The precipitation over the level coastal marsh and prairie is distinctly less than over the broken and wooded uplands. The hills have apparently the greater influence in inducing rainfall, probably by reason of the forced convectional motion in the prevailingly southeast winds.

Immunity from killing frosts is often had in the vicinity of considerable water-areas; partially because of their tempering nature, and partially as a result of the fogs that rise from them and protect adjacent lands, while lands farther removed are unprotected. This latter effect is very noticeable upon the front and back lands of our rivers, especially the Mississippi.

Perhaps no other illustration of the necessity for consulting the meteorological records before embarking in any expensive agricultural enterprise will appeal more strongly or universally to the readers of this report than the failure to make peach growing profitable in Southwest Louisiana. By reason of the mildness of our winters the peach tree is induced to put forth its fruit so early as to be killed by the last frosts. While the trees are vigorous and the fruit luscious; and while each year there is an abundant promise of fruit, yet it is found that not more than one crop in five years can be relied upon.

Such small returns do not justify the labor and expense required, and therefore many vigorous young peach orchards have been cut down.

Should later blooming varieties be developed, or means discovered for retarding their putting forth, peaches may take their place among the profitable fruits of this section.

Though fronting upon the Gulf of Mexico, and on that account having its climate tempered by that large body of warm water, South Louisiana in common with the rest of the Mississippi valley has a distinctly continental climate, and its weather is chiefly under cyclonic control.

The prevailing direction of the wind is from some southern

quarter, and is chiefly determined by the relative position of the section with regard to the tracks of "lows" and "highs" as they cross the continent.

These "lows" (atmospheric *hollows*) and "highs" (atmospheric *hills*), bringing successively cloudy and fair weather, follow a pretty definite course across the United States, being a great southward bending curve with its apex in the Mississippi valley. First appearing upon the Pacific coast they move southeast to about the longitude of the great river, when the direction of progression changes and the remainder of the transcontinental journey is made in a northeasterly direction.

The direction of the wind and character of the weather at any place will depend largely upon its distance and direction from a passing atmospheric disturbance.

A "low" passing to the north or a "high" to the south of a place, if near enough to affect its weather will bring, generally, warmer winds and clouding weather. The reverse of these conditions will produce contrary results.

As the section here considered lies for the most part south of the tracks of the systematic succession of "lows" and "highs" across the Mississippi valley; and as these "lows" *strengthen* while the "highs" *weaken*, as a rule, upon reaching their greatest southing, southerly winds are most frequent. These come from the Gulf moisture laden; and being cooled, both by convectional ascent and by moving into cooler regions, produce an abundant rainfall over the entire section. This is well distributed throughout the year, so that destructive droughts are uncommon.

The tempering effects of Lakes Maurepas and Pontchartrain are felt far into the adjacent flats, and frosts are much less common or damaging than in the hills. Similar effects are produced in Southwest Louisiana by the bordering bays and Gulf.

Throughout South Louisiana maximum temperatures of 100° F. are extremely uncommon, and minimum temperatures below 20° F. are even more rare. Upon the coast freezing temperatures are infrequent.

The range of temperature is about 70° F. in the northern

portion of the section and decreases as we approach the coast.

The annual precipitation varies from 50 to 70 inches, being in the northern part usually between 60 and 65 inches, and decreasing toward the coast where it is commonly under 50 inches. This is well distributed throughout the year. Though there is a minimum of rainfall in midsummer, no season can be considered as distinctively dry.

The winds are variable though prevailingly southern. Thunderstorms are common, and are usually accompanied by strong winds.

Though south of the most frequented tracks of tornadoes, many destructive storms pass through the section; following, as elsewhere in the Mississippi valley a course from southwest to northeast. Their paths through the pine hills and flats may be traced years after their passage by the prostrate trunks of trees.

Summing up we may say: The section is one of *moderate* range of temperature, being less as we approach the coast; of sufficient though not excessive rainfall, likewise diminishing toward the coast, and being well distributed through the year; of variable though prevailingly southern winds, and occasional destructive storms.

Taken as a whole the climate may be properly called temperate.

VI. THE FIVE ISLANDS.

The "islands" of Orange, Petite Anse, Grand Cote, Cote Blanche, and Belle Isle, lying in a northwest and southeast line in Southwest Louisiana, constitute a topographic feature of the coastal plain that has no other American homologue.

While not in the strictest sense islands, yet these detached and limited areas rise so conspicuously above the surrounding prairie and marsh that they are and have ever been referred to as islands.

The most northwestern of the series, Orange Island, lies in

the southern part of township 12 south, range 5 east; and is washed on its northern side by Lake Peigneur. The sometime marshy land to the south has been redeemed and converted into firm pasture land.

About seven miles to the southeast, across several miles of unredeemed marsh, lies the second of the series, Petite Anse, township 12 south, ranges 5 and 6 east. It is entirely surrounded by an easily redeemable marsh, which is drained to the north by Bayou Petite Anse, and to the south by several small bayous that find their sources in the marais along the western slope of the "bluff."

Continuing southeast for six miles through an increasingly swampy marsh, the third and probably largest island of the five, Grand Cote, is reached in township 14 south, ranges 6 and 7 east.

Six miles farther, in the same direction, after crossing Bayou Cypremort, reaches the next of the series, Cote Blanche, in township 15 south, range 7 east. The east, north and west sides face a somewhat deep salt marsh, while the south side rises 50 feet precipitously from Cote Blanche Bay, which is slowly but unceasingly encroaching upon the island. East and west along the bay for several miles stretches the narrow, wave-formed beach, which remains above even high tide except when made excessive by stormy south winds.

A distance of twenty-five miles in a continuous southeast direction from Cote Blanche must be traversed before reaching Belle Isle, the last of the series, in township 17 south, ranges 10 and 11 east. Wholly surrounded by the sea marsh with its branching and inter-branching bayous, and separated by this marsh from the nearest continuous land by a distance of eight or ten miles, Belle Isle is truly an island.

The "Five Islands" thus constitute a series that extends from the south shore of Lake Peigneur in Iberia parish to the shore of the Atchafalaya Bay in St. Mary's parish, a distance of about forty five miles, and upon an almost exact right line.

They all display similar sedimentary deposits; none being probably older than Lafayette, and the Columbia being the in-

variable surface deposits. Characteristic mottled clayey sands, and well rounded pebbles and gravel, with casts of fossils, fix their identity.

Distorted sand and gravel beds, and faulted, indurated and semi-metamorphic beds of sandrock, observed on all the islands, bespeak considerable disturbance since these deposits were made. As such distortions do not extend to the Columbia clays and loams, and as these sink beneath the marsh and reappear in like relation over the prairies, it is fair to presume that the disturbances which produced these dislocations preceded the deposition of those sediments.

The trend of these islands being a continuation of the line connecting the Cretaceous outcrops in Louisiana; and inasmuch as they are underlaid, so far as investigation has gone, by the rock salt deposit which is usually accounted Cretaceous, it has been generally assumed that they are "remnants" of a former continuous Cretaceous ridge, or "back bone" through the State.

In his report "On the Geological History of the Gulf of Mexico" Prof. Hilgard says of these islands, in speaking of the Cretaceous Period: "The outliers in Louisiana are too limited in extent for determinations of dip; but it can scarcely be doubted that they represent the summits of an (more or less interrupted) ancient ridge, a kind of backbone to the State of Louisiana, whose resistance to denudation has measurably influenced the nature and conformation of subsequent deposits.

"It is fair to presume that from this ridge the strata dip toward the axis of the Mississippi valley, to meet those on the opposite side, and the depth at which those beds are found in the Calcasieu bores, seem to indicate, on the western slope, a southwesterly dip of three or four feet per mile.

"A glance at the map shows, nevertheless, that the general form of the northern Gulf shore was not materially influenced by the existence of this axis of elevation, which probably was marked merely by a series of disconnected islands in the early Tertiary sea that, after the emergence of the immense Cretaceous area, already prefigured the present Gulf of Mexico."

Colonel Samuel H. Lockett* in speaking of Cote Blanche

*Second Annual Report of the Topographical Survey of Louisiana, 1870.

and Belle Isle says: "These belong to a chain of five islands, running from northwest to southeast, through the marshes of Iberia and St. Mary parishes. * * * * . The two extreme islands are considerably smaller than the others, but similar to them in every other respect.

"In both a geological and topographical view, these islands are objects of very great interest. Geologically, they evidently belong to the same epoch as the bluff formation of the eastern bank of the Mississippi river. Their surface presents the same water worn appearance, being an alternation of irregular ranges of hills and sinuous valleys. We observe the same precipitous bluffs, with a capping of yellow siliceous silt, underlaid by the lower members of the bluff and the sand and pebbles of the Orange Island formation, while the exact coincidence of the forest growth with that peculiar to other bluff localities, would make a resident of Vicksburg, Port Hudson or Baton Rouge, if suddenly transported to these islands, believe that he was still in the immediate vicinity of his own home.

"Topographically, these islands are a continuation of the Cote Gelee hills, running north and south through the parish of Lafayette. This same range of hills, continuing northward, receives the names Carencro hills in the northern part of Lafayette, Grand Coteau in south St. Landry, the Opelousas hills in the vicinity of the town of that name, and finally abut against the Bayou Boeuf at Washington and Moundville.

"Further north I have not yet traced them, but am of the opinion that future investigations will discover connecting links between the points last named and Sicily Island in Catahoula parish, which is itself but a continuation of the hills of Bayou Magon.

"This line, thus marked out by broken chains of hills and detached islands in the sea marsh swamps, I believe to have been the western shore of a once vast estuary whose limits are coextensive with the present alluvial bottom of the Mississippi river.

"To account for these islands in their present positions, we have but to suppose a series of mighty crevasses through

the great natural levee formed along the border of the estuary. These crevasses were made during the movement of elevation which evidently once occurred throughout the valley of the Mississippi.

"The city of Baton Rouge might have been situated on a similar island, had the erosion that produced the Devil's Swamp, just north of it, been continued a little further so as to meet the head of the valley of Ward's Creek. The rush of waters which would have followed such a result, in some unusually high stage of the ancient Mississippi, can easily be imagined sufficient to sweep away the country for miles back, while the circling eddies just below this hypothetical crevasse would have left unhurt the hills upon which Baton Rouge now stands."

Thomassy found in all the islands proof of "powerful volcanic convulsions," and compared them to the mudlumps of the lower Mississippi delta.

While there are unquestionable evidences of disturbances and earthshocks in these islands, *e. g.*, the arching, folding, and faulting of the Lafayette sands, and the faulting and semi metamorphism of the sand rock, yet I was unable to discover upon any of them any volcanic product whatever. There were undoubtedly earthshocks, but I could not interpret any evidences seen as proofs of "powerful volcanic convulsions."

Although the surface deposits here are like those from Washington south, yet I think we are hardly justified in considering these islands as continuations of the Carencro and Cote Gelee hills. These hills are plainly the products of *erosion*, and show no evidence of disturbance; while the Columbia loams of the islands were spread as a veneering over much disturbed and probably elevated Lafayette deposits. At any rate there was nothing seen to indicate disturbance of the Columbia clays and loams.

The accounting for these islands as remnants of a once continuous ridge, produced by the sweeping away of the intermediate sections in a "series of mighty crevasses through this great natural levee," is hardly tenable, for *crevasses do not occur* in *natural* levees. Moreover, these islands *not* being a *continua-*

tion of the natural levee along the western bank of the ancient Mississippi, but lying to the west of this, it is difficult to see how so great an erosion could be produced at the distance of the islands by streams that could only cut channels now represented by the coulees and marais upon the immediate front lands.

The islands are in all probability, to some extent at least, the result of differential erosion, and as Prof. Hilgard says, an "interrupted ridge;" but this ridge was of *pre* Columbian formation and *interruption*. Whether borings in the marsh between the islands would reveal the same sequence of deposits that the borings upon Petite Anse and Orange Island show, remains to be determined.

In the light of all evidence obtainable, both from published descriptions and personal examination of all of these islands, the following are the conclusions at which I have arrived:

1st. The "Five Islands" are situated upon and are probably remnants of a ridge that has a northwest trend from Belle Isle, and displays outcrops in St. Landry and on Lake Bisteneau.

2d. These outcrops, determined by their characters as Cretaceous, and the rock salt that is known to underlie at a shallow depth at least two of these islands being probably of the same age, the *foundation*, at least, of these islands is Cretaceous.

3d. The fractured, semi-crystalline condition of the limestones in the northern outcrops of this ridge, and the disturbed, faulted and sometimes semi-metamorphic condition of the sand and clay beds on the islands point to *differential elevation* rather than *differential erosion* as the explanation of the origin of the ridge or so-called "Cretaceous backbone" in Louisiana.

4th. Whatever the date of the *origin* of this ridge, and whatever height it may have attained in a former geological period, it was materially increased in the region of the islands during the time of Lafayette elevation and erosion.

This is attested by the following evidence: Lafayette gravels and pebbles that occur in the hills only along old waterways, and could only be brought to their present position by being *rolled along the bottom* are found upon these islands more than

fifty feet above the level of the Gulf; while in Artesian borings to the east and west of this ridge these gravels are reached at depths varying from one hundred to two hundred feet. Gravel and pebbles of this size could not be carried up such an incline by our strongest streams, and the difference between these levels may be taken as a measure of the warping since these beds were deposited. Moreover, these beds of sand and gravel have been *folded* and *faulted*, thus giving unmistakable evidence of differential motion.

5th. The Columbia deposits, especially in its later members, are spread mantle-wise over the disturbed Lafayette, and show no disturbance. This would indicate deposition upon a submerged ridge, and will account for the steep dips observed in these surface deposits.

It would therefore appear, inasmuch as the Lafayette gravels rest directly upon the rock salt, that the "Cretaceous backbone" of Southwest Louisiana had at least an *initial* existence in pre Lafayette times, and the rock salt was unevenly eroded; that during Lafayette emergence and later submergence the strength of the topography was increased by further differential motion; That during early Columbia times this ridge was trenched by strong currents, thus leaving the "interrupted" submerged ridge, which with its later veneering of Columbia sediments was elevated and produced the islands of to-day.

Special descriptions of these islands would be of little economic or scientific interest. They vary chiefly in their surface features. While Grand Cote is distinctly more sandy than Cote Blanche, this is probably due to more extensive removal of Columbia clays and loams.

Belle Isle and Orange Island, the extremes of the series, are smaller than the other islands, and rise one hundred and twenty five and eighty five feet respectively above the Gulf. Belle Isle gives most evidence of disturbance, and in addition to its sour springs and its evidences of gas and oil, exhibits strata of clay well studded with sulphur crystals.

Orange Island is known to be underlaid by *eighteen hundred* feet of rock salt, and the limit not yet reached.

The rock salt mine on Petite Anse displays in section a distinct and almost vertical *banding* of the salt, which suggests bedding, and if so, the enormous thickness of salt passed through is due to this high inclination of the bed rather than great thickness of the original deposit. Investigation of the horizontal extent of these deposits will throw much light upon this question, as will also a critical study of the banded structure of the salt.

Cote Blanche and Grand Cote have up to the present been chiefly devoted to agricultural purposes, for which they are eminently suited.

VII. SOME GEOLOGICAL SECTIONS.

While the geological examination of Louisiana has been too cursory, and the opportunities for determining the sequence of deposits too limited to justify the presentation of a *general* geological section for the State, yet it seems worth while to bring together the sections obtained by former examinations and by my own study of South Louisiana, both east and west of the Mississippi.

As before stated, we are largely dependent upon sections obtained in dug and bored wells for more than the extremely superficial sections afforded by the streams; and as these sections are generally given from *memory* by men who are not geologists, only *general* conclusions may be drawn from them. The increasing popularity of Artesian wells, which sometimes reach a depth of one thousand feet, offers exceptional opportunities for determining the substructure of the State if the companies or individuals boring the wells will take the trouble to preserve specimens of the materials obtained. These specimens should be taken at short intervals—say every five feet, and sent to the Survey headquarters at Baton Rouge. The Survey will pay all freights, and it is hoped that all intelligent citizens will interest themselves in securing this information for us.

The sections presented by the streams that have trenched

their beds deepest display only incoherent, geologically recent sediments.

The following are the sections :

IN THE PINE HILLS.

"*Fluker's Cave,*" on Amite river, in St. Helena parish.

1.	Soil and subsoil	18 inches	Columbia.
2.	Mottled sand and clay	10 feet.	Lafayette.
3.	Red sand rock with pebbles	15 "	
4.	Reddish yellow sand with layers of fine grained clay	25 "	

Some of the pebbles were well rounded, and contained casts of fossil mollusks and crinoids.

The best sections of this portion of Louisiana are obtained from dug wells. These always display beneath a few inches of Columbia veneering first ten to twenty-five feet of mottled clayey sand, massive and glazing upon exposed surfaces; then more stratified deposits of the same general character down to the basal bed of sand, gravel and pebbles. Numerous partings of fine grained, white, or red and white mottled "pipe clay" occur, and sometimes these are reported as much as ten feet in thickness. These deposits indicate formation in a shallow marginal sea with fitful and varying currents.

IN THE PINE FLATS.

1.	Soil and yellowish, sandy Clay	1-3 feet	Columbia.
2.	Mottled clay	10-20 "	
3.	Yellow clay	12-20 "	
4.	Continnous blue clay with frequent water bearing sand layers		

At 40-75 feet, beds of organic matter—logs, leaves, bark, pine cones, etc. are obtained. Water from this horizon has H_2S odor. Artesian water rises 1—20 feet.

The above data were obtained from a well borer at Hammond, La. The Artesian water here is chiefly obtained from what seems to be the basal Columbia gravels. Deeper boring gives stronger flows, and purer water.

IN THE PRAIRIES.

Waterworks well at Jeannerette, Iberia parish :

1.	Red clay	20 feet	Red River deposit.
2.	Sandy mottled clay	60 "	Columbia.
3.	Organic bed—leaves, twigs, etc	10 "	
4.	Sand and gravel	90 "	Lafayette.

Ice factory well at Jeannerette:

1.	Red clay	15 feet	—Red River deposit.
2.	Mottled clay and sand	80 "	Columbia.
3.	Organic bed	10 "	
4.	Sand and gravel	70 "	—Lafayette.
5.	An additional 175 feet in yellow clay		

Artesian well 1 3-5 miles southwest of Jeannerette:

1.	Soil and gray mottled clay	175 feet	Columbia.
2.	Chalky hard pan	18 "	
3.	Blue clay	20 "	
4.	Sand and gravel	20 "	—Lafayette.

Artesian well 3¼ miles southwest of Jeannerette:

1.	Soil and gray mottled clay	140 feet	Columbia.
2.	Shell bed	2 "	
3.	Organic bed	10 "	
4.	Sand and gravel	65 "	—Lafayette.

The above four sections were furnished me by Mr. E. P. Moresi, a well borer of Jeannerette.

Artesian Well at Glencoe, St. Mary parish, La.:

1.	Soil	12— 18 inches	Columbia.
2.	Yellow clay	11 feet.	
3.	Quicksand	12 "	
4.	Blue clay	200 "	
5.	Shale	Undetermined.	
6.	Tough gray clay		
7.	Coarse sand and gravel and water at	615 feet.	—Lafayette.

The above well is situated near Bayou Cypremont, and the section was furnished me by Dr. Simmons, of Glencoe.

Prairie north of Petite Anse, after Prof. Hilgard.:*

1.	Brownish black surface soil	1 foot.
2.	Ferruginous or calcareous gravel, concretionary	½—¾ feet.
3.	Bluish-white silt, mottled with yellow, and hog-ore spots	2½—3 feet.
4.	Blue clay, "similar to that in bed of Bayou Petite Anse"	Not known.

The above section is plainly Columbia.

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*I have reversed the *order* of strata members to agree with order used in Artesian well sections.

Well at Welch, Calcasieu parish, La.:

1.	Soil	6— 8 inches.	
2.	Mottled clay	70 feet	Columbia.
3.	Red quicksand, water besring	20 "	
4.	Chalky clay	50 "	
5.	Blue clay	15 "	
6.	Beach sand and gravel st	100 "	—Lafayette.

This section was furnished by E. L. Earll, a well digger of Welch, La.

Average Section at Lake Charles, La., (contributed):

I.	Soil	10— 15 inches.	
2.	Sandy mottled clay	10— 12 feet.	Columbia.
3.	Red sand	1— 2 feet.	
4.	Mottled clay	40— 50 feet.	
5.	Mottlsd clsysy sand	70—100 feet.	—Lafayette.

Artesian Well at Lake Charles, La., (contributed):

1.	Soil and mottled clay	20 feet.	
2.	Yellow clay	15 "	
3.	Blue clay	20 "	Columbia.
4.	Shale	10 "	
5.	Dark brown clay	135 "	
6.	Variegated sand	127 "	Lafayette.
7.	Sand and pebbles	185 "	
	Artesian water at this level rose 16 feet above surface.		
8.	Continued through quicksand for about 75 feet, when tools became fast and well abandoned.		

Wells at sugar refinery, Lake Charles, La., are Artesian and water very pure from about the 500 foot horizon.

John Buck & Son's brick works in south Lake Charles use soil and clay to depth of 10 or 12 feet. At this depth 2 or 3 feet of quick-sand, and below this 60 to 70 feet of good brick clay.

Brick Works in north Lake Charles:

1.	Soil	10—12 inches.	
2.	Mottled sandy clay	2— 4 feet.	
3.	Reddish sand	2— 4 "	Columbia.
4.	*Pure* red clay	10—12 "	
5.	Fine grained, foul smelling, bluish clay	7— 9 "	
6.	Sand	3— 5 "	
7.	Sand, shells and boulders(?)	3— 5 "	Lafayette.

This section was furnished by Mr. Burnett, the proprietor of the works. No. 4 of the section is possibly Red River deposit, and if so, points to the Calcasieu as the former course of the Red river.

Section of bore at Sulphur Mine, Calcasieu parish, La.:

1.	Yellow and blue clay	80	feet	Columbia.
2.	Sandy blue clay	55	"	
3.	Almost pure blue clay with many sand pockets	30	"	
4.	Fine gray sand—water bearing	135	"	Lafayette.
5.	Coarser, gravelly sand	45	"	
6.	Coarse gray sand	10	"	
7.	Marl (oil and tar)	2½	"	Grand Gulf, or Vicksburg.
8.	Blue, sandy limestone	30½	"	
9.	Calcareous marl	4	"	
10.	Hard, rough, gray Calcareous marl	5	"	
11.	White saccharoidal Calcareous marl	10	"	
12.	Same reduced to sand	7	"	
13.	Hard, compact limestone	25	"	Cretaceous.
14.	Sulphur	112	"	
	Bottom of sulphur at	540	"	

Section of present working hole at Sulphur Mine:

1.	Clay, sand, gravel, etc	300 feet	—Columbia and Lafayette.
2.	Shelly (bastard) limestone	80—100 "	—Grand Gulf, or Vicksburg.
3.	Solid limestone	6—7 "	Cretaceous.
4.	Sulphur	110 "	
5.	Soft, white rock	200 "	

Piping stops at upper surface of No. 3. The above two sections at Sulphur Mine kindly furnished by Mr. J. C. Hoffman, superintendent of the works.

Approximate Section at Edgerly, La., (contributed):

1.	Sandy, chocolate colored soil	12—15 inches.	Columbia.
2.	Mottled clay	3— 5 feet.	
3.	Gray sand	4— 6 "	
4.	Clay	3— 5 "	
5.	Red quick-sand, water bearing, undetermined		—Lafayette.

IN THE "BLUFF."

River Section at Tunica Hills, West Feliciana parish, La.:

1.	Yellow loam	Undetermined.	Columbia.
2.	Loess	150 feet.	
3.	White clay with calcareous concretions	Port Hudson strata, undetermined.	
4.	Whitish blue clay		

Section at St. Francisville, West Feliciana parish, La.:

1.	Yellow loam	10 feet.	Columbia.
2.	Yellow sand (like the transition between the loess and drift)	9 "	
3	Whitish sandy clay and sand in several alterations	Port Hudson group, undetermined.	
4.	Sandy silt with roots		
5.	Whitish-blue clay		

River Section at Port Hudson, East Feliciana parish, La.:

1.	Yellow loam	5 feet.	Columbia.
2.	White and yellow hardpan	20 "	
3.	Three layers of bluish joint clay	21 "	
4.	Sand, indurated above and below, loose and white in middle	24 "	
5.	Ledge of layers of clay solidified by iron rust	3 "	
6.	Massive clay, blue and very smooth	13 "	
7.	Stump stratum and leaf bed in blue shale	4 "	
8.	White clay	3 "	

River section, five miles above Baton Rouge, La.:

1.	White hard pan, yellow above	17 feet	Columbia.
2.	Indurated clayey sand, laminated	11 "	
3.	White and yellow spotted clay, with clayey lime concretions	24 "	

River section at Baton Rouge, La.:

1.	Brownish yellow loam	23½ feet	Columbia.
2.	Yellow and white hard pan, with ferruginous concretions	15 "	
3.	Yellow clay, with limy concretions	16½ "	

The foregoing five sections, extracted from Hopkins' Third Report, represent the only *natural* sections of importance in the "bluff" region east of the Mississippi in Louisiana. As always I have numbered the members of the section from top down; otherwise the sections are unchanged.

Railroad cut at Washington, St. Landry parish, La.:

1.	Yellowish brown loam	10 feet	Columbia.
2.	Yellow clay, with lime concretions	5 "	
3.	Mottled clay, with iron concretions	5 "	

Sea cliff at Cote Blanche—After Hilgard:

1.	Soil and (brown loam) subsoil	5 feet	Columbia.
2.	Stiff greenish brown clay with dendrites	5 "	
3.	Stiff brown clay with black streaks	7 "	
4.	Reddish gray loam with ferruginous spots and Calcareous nodules	8—18 "	
5.	Hard pan, mottled white and yellow	4 "	
6.	Tough greenish clay with Calcareous concretions	——	
7.	Same, non-Calcareous	2 "	
8.	Gray loam (partly hidden by talus) about	8 "	
9.	Reddish, orange, gray or mottled loam, with ferruginous concretions	2 "	
10.	Cypress muck and lignite about tops of stumps	½ foot	
11.	Blue and green sandy clay with cypress roots—visible.	1 "	

The sections here presented suffice to show that in South Louisiana, hill, flat and prairie alike display only Columbia and Lafayette deposits in *natural* sections made by streams ; and that dug wells never, and Artesian wells but rarely reach below these deposits.

The mottled Columbia clays are displayed in the vertical banks along the north shore of Lake Pontchartrain, and along the north shore of the Gulf in Southwest Louisiana ; and the stratum of organic matter is persistent over the flats and prairies.

It is possible as Prof. Hopkins says, that the Cretaceous formation underlies the whole State ; but in most places at such depth that deep Artesian wells fail to reach it.

A deep well is now boring at Baton Rouge, and it is hoped that a study of the section which is being carefully taken, will throw new light upon the substructure of the State.

THE FLORA OF THE SECTIONS REPORTED UPON IN THIS BULLETIN.

The following notes on the botanical features of these sections are made by Prof. W. R. Dodson, Botanist of the State Experiment Station, who accompanied the Survey through the Florida Parishes and made, personally, the collections; and who examined the collections made by Cadet Matthews under his direction, who accompanied the Geological Survey through Southwest Louisiana. These lists constitute only a part of the plants of these sections, being confined chiefly to those of an economic value. At some early day a bulletin will be issued covering all of the plants of the State so far investigated by this department.

WM. C. STUBBS,
Director.

After making a careful study of the notes and collections of Mr. Matthews on the flora of Southwest Louisiana, and comparing them with my own on the Florida Parishes, I find the regions so strikingly similar that a separation of the two reports would be useless repetition, hence the two sections are included in the following.

There are a good number of plants found in each section not found in the other, but they are not of importance here.

Respectfully,
W. R. DODSON.

THE PRINCIPAL PLANTS OF ECONOMIC VALUE IN THE FLORIDA PARISHES AND SOUTHWEST LOUISIANA.

BY W. R. DODSON, BOTANIST.

TREES.

Long leaf Pine (*Pinus australis*) may be said to be the principal forest growth, both in the hills and in the pine flats. An immense quantity of marketable timber remains yet untouched.

Short leaf Pine, Loblolly Pine, Old Field Pine (*Pinus tæda*), is the principal pine west of the Amite river, to within a few miles of the Mississippi river, and is scattered all over the Florida Parishes and the southwest, but becomes the predominant forest growth only in very limited spots and in land that has once been under cultivation.

Northern short leaved Pine (*Pinus mitis*), is found sparingly in the bottoms of the Amite, Tangipahoa and Pearl rivers, and south of Alexandria.

White Pine (*Pinus strobus*). A few trees are frequently met with in the creek and river bottoms.

Pond Pine (*Pinus serotina*) is frequently met with in the vicinity of Pearl river.

Cypress (*Taxodium distichum*) occurs in all the river bottoms in the sloughs and low places, and in considerable quantities in most of the swamps.

OAKS.

White Oak (*Quercus alba*) moderately abundant and of good size on most of the creek bluffs; frequently along branches in the hills, but seldom exceeding 12 inches in diameter there.

Cow Oak (*Quercus michauxii*) is not generally distinguished from the White Oak, the timber qualities being just as good in

every respect. It is found in moderate abundance in the bottoms of all the streams. It is generally a larger growth than the White Oak.

Water Oak (*Quercus aquatica*) is quite plentiful along most of the streams:

Willow Oak (*Quercus phellos*). Large trees frequently seen about the margins of swampy places and on creek banks, but not abundant anywhere.

Shingle Oak (*Quercus imbricaria*) is found occasionally in the upper bottoms of most rivers in the upper parishes.

Post Oak (*Quercus obtusiloba*) is found in considerable quantities in the hills for several miles on each side of the Amite river, and is occasionally met with throughout the hills and the northern portion of the flats.

Black Oak (*Quercus tinctoria*) in moderate quantities through the northern parishes, but mostly limited to hillsides near streams.

Black Jack (*Quercus nigra*), scrubby growth throughout the hills, but never predominant, accompanying long leaf pine.

Spanish Oak (*Quercus falcata*), mostly associated with Black Oak, not quite as abundant.

Live Oak (*Quercus virens*) is quite abundant in the lower parishes, especially on bayous and in the vicinity of the lakes.

Beech (*Fogus ferruginea*) is abundant in most all creek bottoms, a few areas in the uplands and what is called the bluff lands along the Mississippi river. Large trees are plentiful.

Magnolia (*Magnolia grandiflora*) is quite abundant in bluff lands and in most of the creek and river bottoms, and in the flats in the vicinity of bayous.

Sweet Bay (*Magnolia glauca*), generally found with Magnolia in wet places and near standing pools.

Sweet Gum (*Liquidamber styraciflua*). Large trees are moderately abundant in the bottoms of rivers and larger creeks and in the more or less swampy lands.

Black Gum (*Nyssa sylvatica*) sparingly through the hills, common on the branches that are running water most of the season.

White Ash (*Fraxinus Americana*) is moderately abundant in low places in the bluff lands, and many creek and river bottoms throughout.

Pecan Nut (*Carya olivæformis*) is frequently met with in the bottoms of nearly all the streams and bayous.

The following trees and shrubs of minor importance are found more or less abundant in the bottoms of most all streams and branches, and on hillsides bordering on streams, and some of them less abundant through the hills :

Magnolia umbrella, Umbrella Magnolia.
Magnolia macrophylla, Large leaved Magnolia.
Liriodendron Tulipifera, Poplar.
Illicium Floridonum, Anise Tree.
Asimina triloba, Papaw or Crusted Apple.
Tilia Americana, Bass wood Linden.
Zanthoxylum Carolinianum, Prickly ash, Toothache tree.
Rhus glabra, Sumac, smooth.
Rhus capollina, Dwarf sumac.
Rhus aromatica, Polecat Bush.
Rhus Toxicodendron, Poison Ivy, Poison Oak.
Vitis bipinnata, Goose Grape.
Vitus Labrusca, Fox Grape.
Vitis vulpina, Muscadine.
Ceanothus Americanus, Jersey Tea.
Aesculus Pavia, Smooth Buck Eye.
Acer dasycarpum, Silver Maple.
Acer rubrum, Red Maple.
Negundo aceroides, Box Elder.
Wistaria frutescens, Wistaria.
Cercis Canadensis, Red Bud, Judas Tree.
Gleditchia triacanthos, Honey Locust.
Gleditchia monosperma, Honey Locust.
Prunus Americana, Plum.
Prunus Pennsylvanica, Wild Cherry.
Rubus Villosus, High Black Berry.
Rubus Canadensis, Dew Berry.
Rubus hispidus, Swamp Blackberry.

Rosa loevigata, Cherokee Rose.
Crataegus crus-galli, Cockspur Thorn.
Crataegus flava, Summer Haw.
Cornus florida, Flowering Dogwood.
Cornus stricta, Stiff Carnel.
Cornus sericea, Kinnikinnik.
Nyssa uniflora, Tupelo Gum.
Sambucus Canadensis, Common Elder.
Lonicera sempervirens, Honeysuckle.
Viburnum prunifolium, Black Haw.
Cephalanthus occidentalis, Button Bush.
Gelsemium sempervirens, Yellow Jessamine.
Vaccinium arboreum, Huckleberry.
Oxydendrum arboreum, Sour Wood, Sorrel Tree.
Ilex opaca, Holly.
Ilex decidua, Deciduous Holly.
Diospyrus Virginiana, Persimmon.
Bumelia lanuginosa.
Tecoma radicans.
Solanum, shrubby species undetermined.
Fraxinus viridus, Green Ash.
Sassafras officinalis, Sassafras.
Morus rubra, Mulberry.
Ulmus fulva, Slippery Elm.
Ulmus Americana, Elm.
Ulmus alata, Winged Elm, Whahoo.
Celtis occidentalis, Hackberry.
Platanus occidentalis, Plane Tree, Sycamore.
Carya alba, Shellbark Hickory.
Carpinus Americana, Hornbean.
Salix nigra, Willow.

The following are some of the medicinal and economic herbs:
Clematis crispa, Virgin's Bower.
Clematis viorna, Leather Flower.
Ranunculus sceleratus, Cursed Crowfoot.
Cocculus Carolinus.
Podophyllum peltatum, May Apple.
Nymphæa odorata, Pond Lily.
Sarracenia purpurea, Huntsman's Cup.
Sarracenia Psittacina, Parrot Beaked Pitcher Plant.
Sarracenia flava, Trumpet leaf, Watches.
Nasturtium officinalis, Water Cress.
Sisymbrium canescens, Tansy Mustard.
Lepidium Virginicum, Peppergrass.
Capselly Bursa pastoris, Shepherd's Purse.
Viola cuculata, Blue Violet.
Viola pedata, Bird foot Violet.
Viola primuloefolia.
Helianthemum canadense, Rock Rose.
Drosera capillaris, Sundew.
Drosera brevifolia.
Ascyrum Crux Andreæ, St. Peter's Wort.
Hypericum—several species, St. John's wort.
Portulaca oleracea, Purslane.
Mollugo verticillata, Indian Chick weed.
Stellaria media, Chick weed, Troublesome weed.
Stellaria prostrate.
Sida spinosa, Troublesome weed.
Modiola multifida, Modiola.
Hibiscus Moscheutos, Wild cotton.
Hibiscus incanus, Wild cotton.
Oxalis stricta, Yellow Wood sorrel.
Geranium Carolinianum, Cranesbill.
Cardiospermun Halicacabum,
Polygala, several species.
Psoralea melilotoides.
Tephrosia Virginiana, Goat's Rue.
Astragalus Canadensis, Milk Vetch.

Vicia Caroliniana, Vetch or Tare.
Apios tuberosa, bearing edible tubers.
Phaseolus diversifolius, Wild Bean.
Baptisia, several species.
Cassia Marilandica, Senna.
Cassia nictitans.
Potentilla Canadensis, Cinquefoil.
Fragaria Indica, False strawberry.
Passiflora incarnata, May Pop, Passion Flower.
Passiflora lutea.
Eryngium Virginianum, Button Snake Root.
Elephantopus Carolinianus, Elephaut's Foot.
Tiatris elegans, Button Snake Root.
Tiatris spicata, Button Snake Root.
Solidago—several species, Golden Rod.
Helenium tenuifolium, Bitter Weed.
Helenium quadrangulatun, Sneeze Weed.
Maruta cotula, May Weed Chamomile.
Gnophalium polycephalum, Everlasting.
Senecio aureus, Golden Butter Weed.
Lobelia cardinalis, Cardinal Flower.
Specularia perfoliata, Venus' Looking Glass.
Verbascum Thapsus, Mullein. Introduced.
Mimulus rivgens, Monkey Flower.
Veronica arvensis, Speedwell.
Callicarpa Americana, French Mulberry, shrub.
Mentha viridis, Mint. Introduced.
Calamintha Caroliniana, Calamint.
Brunella vulgaris, Self Heal.
Lamium amplexicaule, Dead Nettle, weed.
Cuscuta compacta, Dodder.
Solanum nigrum, Black Nightshade.
Solonum Carolinianum, Horse Nettle.
Physalis pubescens, Ground Cherry.
Datura stramonium, Jamestown weed, Thorn Apple.
Asclepias tuberosa, Butterfly weed, Pleurisy Root.
Aristolochia serpentaria, Virginia Snake Root.

Phytolacca decandra, Poke weed.
Chenopodium album, Pig weed.
Chenopodium anthelminticum, Worm seed.
Benzoin odorifera, Spice Bush, shrub.
Phoradendron flavescens, Mistletoe.
Croton Elliottii, Croton.
Urtica urens, Dwarf nettle.

FORAGE PLANTS AND GRASSES.

Almost the entire area of the southern portion of the State is clothed to some extent with sedges, that are valueless, but the number of valuable forage plants that have refused to be crowded out demonstrates that they would flourish profusely if given a chance by cultivation. Lespedeza (*Lespedeza striata*), a valuable hay and forage plant, is becoming very generally distributed through the woods and is taking possession of hills and valleys alike. It is said to have made its appearance only within the last few years.

The frequent occurrence of various species of the Pulse family is striking. Two or three species of Desmodium, that are relished by cattle, are abundant. Quite a number of native grasses are found scattered through the forests that would afford good grazing for pasture if the timber was cleared off. Also a large number of grasses that are of no value as forage plants are found. All these will be included in a later report which will attempt to give all that is known of the flora of the State.

The following are some of the common grasses relished by stock that occur in considerable abundance, either wild, in open fields, or spontaneous in cultivated grounds:

Alopecurus pratensis, Meadow Foxtail.
Sporobolus Indicus, Smut Grass.
Sporobolus junceus, Wire Grass.
Cynodon Dactylon, Bermuda Grass. Introduced.
Elensine Indica. Cultivated grounds. Introduced.
Eragrostis Purshii.
Paspalum platycaule, Louisiana Grass.
Paspalum dilatatum, Hairy flowered Paspalum, Bull Grass.

Paspalum distichum.
Panicum sanguinale, Crab Grass.
Panicum filiforme, Hairy Crab Grass.
Panicum Crus-galli, Tall Panic Grass, Barn yard Grass.
Panicum filiforme.
Panicum virgatum.
Andropogon furcatus, Broom Grass.
Poa annus, Meadow Grass. Introduced.

PART IV.

GEOLOGY AND AGRICULTURE.

A PRELIMINARY REPORT

UPON

The Bluff and Mississippi Alluvial Lands

OF

LOUISIANA.

BY

W. W. CLENDENIN, M. S., M. A., Geologist.
MADE UNDER DIRECTION OF STATE EXPERIMENT STATION,
Baton Rouge, La.
WM. C. STUBBS, PH. D., Director.

LOUISIANA STATE UNIVERSITY AND A. & M. COLLEGE.

BUREAU OF AGRICULTURE.

GOV. MURPHY J. FOSTER, President.
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The Bulletins and Reports will be sent free of charge to all farmers, by applying to Commissioner of Agriculture, Baton Rouge, La.

OFFICE OF STATE EXPERIMENT STATION,
LOUISIANA STATE UNIVERSITY AND A. AND M. COLLEGE.
Baton Rouge, La.

Major J. G. Lee, Commissioner of Agriculture and Immigration, Baton Rouge, La.:

DEAR SIR—I hand you herewith a report upon "The Bluff and Mississippi Alluvial Lands of Louisiana," by Prof. W. W. Clendenin, who has recently made a preliminary survey of these sections of the State. This completes the preliminary survey of the State, and work has already been begun in a detailed survey by parishes. Beginning at the northwestern corner of the State, this work has already covered the parishes of Caddo and Bossier, and will be prosecuted in order until the entire State has been traversed.

A large number of typical soils, marls, clays, etc., have been collected and are now being analyzed by the chemical and physical laboratories of the Station. Mr. E. Stanley Matthews, the physicist, has already completed the mechanical analyses of nearly four hundred samples of soils. At an early day a special report upon "The Soils of Louisiana" will be made, containing a detailed description of the various soils of this State, together with their chemical and mechanical analyses.

Please publish this report as Part IV, Geology and Agriculture.

Very respectfully submitted,
WM. C. STUBBS,
Director.

LETTER OF TRANSMISSION.

Dr. Wm. C. Stubbs, Director State Experiment Stations, Raton Rouge, La.:

SIR—I herewith present to you a preliminary report upon "The Bluff and Mississippi Alluvial Lands of Louisiana." The material for this report was collected during the summer of 1895. The soils collected are being analyzed as rapidly as the force of the laboratories permits.

Respectfully submitted,
W. W. CLENDENIN,
Geologist.

Bluff and Mississippi Alluvial Lands of Louisiana.

I. INTRODUCTION.

In Part III, "Geology and Agriculture of Louisiana," a brief consideration was given to the Bluff Lands of East and Southwest Louisiana. The following report will be limited to a preliminary study of the border lands of the Mississippi River, which are directly the product of the river itself. The data of this report were collected during the field season of 1896, when the bluff lands and Mississippi alluvial lands were examined from the Arkansas line to the Gulf of Mexico. Being of most recent geologic age, and simple and uniform in attitude, the study of these lands was almost exclusively along the lines of physical geology. As these constitute an important part of the agricultural lands of the State, a very complete and typical set of soil samples were taken for analysis and study. Being the immediate product of the Mississippi River, in order to a better understanding of the conditions and features discussed, the following brief consideration of the development and work of a river and its application to the Mississippi is here presented:

LIFE HISTORY OF A RIVER.

We are too prone to look upon so large a geographic feature as a river, and especially the Mississippi, as something that has always existed and will ever continue to exist practically as we know it. We see indeed, that certain changes occur, such as a slight shifting of channel, and, may be, what appears to us to be a *permanent* change of channel; a cutting of banks, no matter their height, in one place and filling of bed in another; once in a lifetime, perhaps, observing a *natural* cut-off made by the river to secure a more direct route to its goal, the sea, yet we find it difficult to look upon these as

more than mere *accidents* to the river, and still more difficult to conceive of the river's having had a *beginning*.

Our fields are scarred with ever-branching and troublesome washes, which extend headward and deepen and broaden with every rain, and we may have discovered that the creeks and smaller branches have their beginnings in these self-same washes, yet we do not ordinarily comprehend the unbroken chain of which the furrow we make to drain our field and the mighty Mississippi are the end links. When we do realize this fact we can then appreciate the broader fact, viz.: That rivers, as men, have their *youth*, their *adolescence*, their *maturity* and their *old age*, and just as a man is more active and able to do work in his early manhood, so with the river in its adolescence.

THE RIVER'S BIRTH.

As no land area of sufficient extent for the development of a river upon it has emerged from the sea in historic time, we have no record of the birth of a river; yet upon islands of the sea and the coast lands of Louisiana we have the principle exemplified, and these may be taken as types of larger areas that have emerged.

Whenever a land area appears above sea level for the first time, and precipitation falls upon it, rivers are *born*. If the surface be an even one the river's course is definitely down the slope on the steepest gradient. The precipitation uniting along lines rather than flowing off in an unbroken sheet (which could occur only upon an ideally smooth surface) has power to do work. This work, which is constantly being done by all running water, is chiefly of two kinds: *erosion of the surface and transportation of the materials eroded.* These two species of work are inseparable. Each is a function of the other. *Pure* water has little power to erode, and water loaded with sediment is equally ineffective as an agent of erosion. Atmospheric agencies and gravity are active in furnishing materials for transportation, and these serve as tools for the work of erosion. Transportation of material must be first attended to, and erosion follows after.

The ability of a stream, both to transport material and erode its bed, depends upon its volume (which in turn depends

upon drainage area and amount of precipitation), and in a multiplied ratio upon its velocity. If the velocity be *doubled* the power to erode is increased *four* times, and the transporting power is increased *sixty-four* times. We will find this to be most important in explaining certain topographic features of the area under discussion.

ADOLESCENCE OF RIVER.

With the development of the primary stream *down* the slope, lateral branches oblique to it are developed, and in like manner branches of a third, fourth and indefinitely higher order until the area is covered by a branching and rebranching *system* of drainage lines not unlike the branching of a tree, and is completely drained. During this period of *adolescence* when new branches are forming and older ones are extending headward and widening and deepening their channels, the *rate* of development will be largely determined by the slope of the region or its altitude above sea level.

The final slope toward which every stream wears its bed, and which, if time is sufficient, it will attain, is one so slight that the water flows down it without erosion and without load. This slope is rapidly approached during the youth of the stream, but is attained only in old age, and soonest in its lower course. On this account young rivers have valleys that are deep in comparison with their breadth, and are V-shaped. Another youthful feature is waterfalls, which result from great inequalities of hardness of strata cut through by the stream. These, as also the V-shaped valleys, disappear long before old age of the stream.

MATURITY OF RIVER.

When the branches of the stream have been multiplied and extended until every part of the area has been reached, and no broad, undrained inter-stream areas remain, the stream is said to be *mature*. The water sheds are sharp ridges. Long before this period is reached lateral waste of valley sides exceeds the rate of cutting along bed of stream, and the valley widens much faster than it deepens. Any further erosion of area now tends to reduce the inequalities of surface topography, and to bring the region to its final goal, sea level. The

stream no longer, or but slowly, cuts down its bed, and this spasmodically, occasioned by flood stages. During ordinary stages no deepening of channel occurs, and at extreme low water there may even be deposit upon the bed.

OLD AGE OF RIVER.

With the nearer approach of tributaries and upper courses of the stream to the base level of erosion there follows a reduction in velocity of current, and often a partial filling of former valley in lower courses. Old age draws on. What with extended channel, built with sediment gathered from its entire basin and deposited at its mouth, and the decreased slope, due to cutting toward base level in its upper part, the current is so weakened that near its mouth it cannot longer do the work imposed upon it by its more vigorous upper members, and some of the load must be laid down. If, at the same time, by depression of land in its upper courses, the slope is further decreased, deposit in the lower part is accelerated. If now, by change in climatic conditions, a smaller volume of water is supplied, the river may sink to a mere pigmy representative of its former self, and occupy but a small channel in its more or less completely filled valley.

NATURAL LEVEES.

With every flood the river now overflows its flood plain and deposits much of the sediment from its head waters. As with a *slight* increase in velocity the transporting power is *vastly* increased, so with a slight checking of velocity, as occurs over the flood plain outside of the channel, deposit takes place. As the greatest decrease in velocity takes place *near* the channel, there the heaviest and coarsest sediment is deposited, and in greatest quantity. The river banks are thus built higher by each flood and a system of *natural levees* are produced. There is thus a marked difference in the "front lands" and the "back lands" along the river. The former are higher and coarser textured than the latter, and therefore much more easily cultivated and drained.

DISTRIBUTARIES.

Drainage from the very channel margin is away from the river, and unless forced by the topography of the land, will not reach the river proper, but unite with some outlet of the river produced during some extraordinary flood period and kept open by the escape of water during ordinary periodic flood stages. As the feeders of the river are called *tributaries*, these outlets have not inaptly been styled *distributaries*.

MEANDERS AND CUT-OFFS.

With weakened powers, characteristic of old age, the stream frequently finds it easier to go *around* an obstacle in its path than to *remove* it. Thus, a stranded log or deposit made by the river at low stage may serve to deflect the current from its course and thus change the course of the main channel. With a slight departure of the channel from a right line there follows an increased bending of the line of swiftest current, and though the channel may not be perceptibly deepened, the impinging current will cut away the bank against which it is thrown, while the opposite bank builds up. By continued and augmented deflection of the current with its consequent erosion upon the convex side of the curve and deposit of materials upon the concave, the channel is finally made to assume the form of an ox-bow. This increased length of course, due to meandering, is accompanied by a decreased average slope of the river bed. Where the direct course had a fall of six inches to the mile, the meandering stream may have to traverse several miles to secure the same fall. As a consequence, at flood stages, when the river spreads over its flood plain, there is a tendency to find a more direct route with steeper slope. In doing so, the longer course is abandoned and a "cut-off" produced. In course of time the ends of the abandoned course become silted up and a "horseshoe" lake is formed.

These abandoned sections of a former course are unfailing evidence of the old age and weakened powers of the river. By a comparison of streams that meander, it will readily be seen that the extent of the meandering, measured by the

diameter of the loops made when cut-offs occur, is largely a function of the volume of the stream.

By depression of the land at its mouth a river in any stage of development may in its lower course be drowned; while, on the other hand, by elevation of the land the river may be extended mouthward, and its activities renewed.

As development proceeds headward, the river may, and does display all stages of development in its various parts. As the conditions of volume and load are usually such as to bring the lower course of the river soonest to base level, this, together with the fact that the lower course is usually the *oldest* part of the river, will explain why the average slope gradually increases as we go toward the source.

APPLICATION TO MISSISSIPPI RIVER.

The Mississippi river was in existence previous to the last great continental subsidence that submerged almost all, if, indeed, not every portion of Louisiana. If our interpretation is correct its valley was cut by a vastly greater stream than its present self, and when the continent stood at a much greater elevation. At any rate *river* deposits have been penetrated at New Orleans to the depth of over 600 feet; and when the Mississippi again assumed the functions of a river upon the emergence of the State from the sea, it seems to have produced *natural levees* at Vicksburg, Natchez and Baton Rouge upon the eastern bank, and upon the west along the Macon hills, at Sicily Island, at Marksville, and from Washington to New Iberia and Belle Isle. These seem therefore just and proper east and west limits to fix upon for the ancestor of our present Mississippi.

While the ancient Mississippi was not by natural development an *old* river when its cycle of existence was ended by subsidence of the continent, yet upon its renewal by re-elevation the attitude of the land was such as to impress upon it all the characteristics of an old stream. Within limits determined by its volume and the varying attitude of the land it has meandered as only streams that have reached their base level of erosion do; has built high, broad natural levees; and, until modified by the hand of man, maintained such distribu-

taries as were needed for the disposition of its waters at flood stages. Within the limits of Louisiana it has but one tributary flowing from the deposits in its ancient bed, the Red river, and even this would, unless prevented by human devices, find a passage to the sea by one of the distributaries, the Atchafalaya. Only from New Orleans to the Gulf, which is plainly a geologically *very modern* extension of the river, has the life of the river been too short for any considerable meanders and consequent cut-offs. From Donaldsonville, the head of the last considerable distributary, to Port Hudson, the greater age of the river is shown by its more sinuous course, and above Port Hudson *all* the features of an *old* river are displayed.

II. DESCRIPTION OF REGION.

GEOGRAPHY.

The area covered by this report has no natural geopraphic boundaries. As previously stated, it comprises all the lands in Louisiana which are the product of the Mississippi river, both the modern alluvial lands, and that more ancient alluvium, the "bluff" lands that border the modern alluvium. This forms a somewhat irregular zone stretching over about four degrees of latitude, and varying in width from about fifteen miles at the Arkansas line to about one hundred miles from the line of the Five Islands on the southwest to Tickfaw river on the northeast. As measured by the present channel of the Mississippi River the distance from the Arkansas line to the Gulf is about four hundred and fifty miles. The eastern boundary is the Mississippi river, from the Arkansas line to the northern border of West Feliciana parish, and from thence an indefinite and irregular line extending roughly southeast from near Laurel Hill in West Feliciana parish to the mouth of the Tickfaw river, and passing near Jackson and Ethel in East Feliciana, and crossing the Amite river near the mouth of Sandy creek. The western boundary is an equally irregular

line skirting the eastern edge of Bœuf river alluvium from the Arkansas line to Sicily Island; thence southwest to the Red River, about ten miles below Alexandria, passing near Harrisonburg and through Catahoula lake; thence southeast along the northern border of Red River alluvium to the western boundary of Avoyelles parish; thence by an interrupted line to Washington La., passing through Evergreen in Avoyelles parish and crossing Bayou Cocodrie in Tp. 4 S., R. 3 E.; thence southward to Lake Peigneur and southeastward through the Five Islands to the Gulf.

From the nature of the case these boundaries are indefinite and only approximate. While in some places definitely marked by differences of soil and growth, as a rule these grade so imperceptibly into those of adjacent regions as to make their definite separation impossible. No such difficulty obtains in regard to the separation of the bluff, or ancient alluvium, from the modern. These are sharply defined by natural geographic boundaries, which are easily traced. The bluff lands invariably rise above the modern alluvium in the form of an escarpment, closely bordered by a bayou. In the Florida parishes this escarpment rises from a few feet, near the mouth of the Tickfaw, to about seventy-five feet at Baton Rouge, and if we consider the average level of the Mississippi as the level of the modern alluvium, to several hundred feet in the Tunica Hills of West Feliciana parish. The western escarpment varies from fifteen to twenty-five feet throughout most of its length. The modern Mississippi closely follows the eastern escarpment from the northern boundary of West Feliciana parish to Baton Rouge, where it bears away from it, leaving a large area of impenetrable marsh and swamp, and a narrow zone of cultivable land between.

In most essential features the bluff and modern alluvial lands are so unlike, it seems best to consider them separately.

THE BLUFF LANDS.

These are believed to be the border lands of the ancient Mississippi River. They display many characters of natural levees, being highest in front and sloping back until they feather out or lose their distinctive character at distances

varying from one to twenty-five miles. Being built of materials very homogeneous in character they do not display the variation in coarseness seen in similar modern deposits between "front" and "back" lands, but rather proclaim their origin in their greater thickness upon the front.

As stated in "Part III Geology and Agriculture" of Louisiana, we believe these deposits to be glacial rock-flour, carried by greatly strengthened streams from the melting ice of the glaciers in the North, and therefore *post-glacial* in their formation. They are so even textured and homogeneous in character as to enable them to resist the ordinary processes of weathering almost indefinitely, and yet so friable as to yield most rapidly to sediment-laden running water. These characters enable them to stand unsupported for decades in vertical walls, but they erode rapidly when put in cultivation.

The bluff lands east of the Mississippi river comprise about a thousand square miles, distributed as follows: West Feliciana, 250; East Feliciana, 75; East Baton Rouge, 300; Livingston, 325; Ascension, 50. In the Felicianas and East Baton Rouge parishes they grade insensibly upon the northeast into the "good uplands," characterized by a mixed growth of hardwood and pine; and in Livingston they pass as gradually into the long leaf pine hills and flats. In Ascension the bluff lands are comprised in a few island-like masses that border Bayous Manchac and Chene Blanc.

The bluff area bordering the modern Mississippi alluvium upon the west is of such irregular and indeterminable extent that it is difficult even to estimate the amount in square miles. It is usually locally designated as "hills," "islands" or "prairies." Beginning at the north, we have the Bayou Macon hills, which border Bayou Macon on the west; and gently sloping westward with little change of character to the alluvial lands of Bœuf river, comprise in the parishes of West Carroll, Richland and Franklin an area of scarcely less than a thousand square miles. These deposits, while bearing the same relation in position to the ancient Mississippi as the bluff lands in a corresponding latitude in Mississippi, and as those in the Felicianas, and while evidently of Columbian age, have not many of the characteristics of the loess. They are more

of a loamy clay than they are of the genuine loam of the loess.

Crossing Deer creek southward from the Macon hill—a creek of *very* modern origin—we arrive at Sicily Island, which, in addition to its rocky hills of a more ancient geologic age, comprises about forty square miles of genuine bluff land.

Continuing southwestward along the margins of the pine hills to Red river, small areas of bluff are found at Harrisonburg and about the outlet of Catahoula lake, and again, south of that lake. Catahoula prairie, Holloway prairie and Long prairie are local names for parts of these.

Between Red river and Bayou Courtableau the bluff lands appear as small, detached areas, as Avoyelles prairie (the largest), Grand Ile, Grand Cote, Bayou Rouge prairie, and a few other small areas without particular names.

A few miles above Washington, in St. Landry parish, upon the right bank of Bayou Cocodrie, the bluff reappears and continues with only slight interruption, by modern streams, in an unbroken zone almost to Franklin, in St. Mary parish. Various local names for this deposit are Opelousas hills, Carencro hills and Cote Gelee hills, all of which slope gradually to the west and merge imperceptibly into the prairies of Southwest Louisiana.

The Five Islands display bluff deposits, but at a much greater altitude, due probably to elevation since their deposition.

As described in a former report, the topography of the bluff lands of the Florida parishes and of Southwest Louisiana may be described as *young;* although on account of their altitude, the drainage is fairly developed. The Macon hills display an even more youthful phase of topography, owing, no doubt, to inferior elevation. In them there are wide undrained, or, at least, poorly drained inter-stream flats, and the streams are of the simplest unbranched type. This is not because the region is not sufficiently elevated for complete drainage, but because, with its given elevation, time has not been sufficiently long to permit a widely branched system of drainage to be developed. Only near the eastern and western margins is drainage anything like complete. The streams are apparently of post-Columbia development, there being none like Rio Feli-

ciana apparent inheritances from Lafayette times. Whatever the character of Lafayette topography and drainage in the Macon hills its burial and obliteration by Columbia sediments has been so complete as to leave no trace of it. The streams almost invariably begin in gum swamps, or hickory and oak flats, and pursue their sinuous courses with but few tributaries and in steep-banked channels.

Throughout the parishes of West Carroll, Richland and Franklin, the zone of Columbia deposits is crossed from northeast to southwest by a series of low ridges enclosing the flats or swamps. These seem to be the homologues of those south of Opelousas to Franklin produced by the "coulees" and "marais," and are doubtless of similar origin. Thus, the Macon hills, as the Opelousas hills and Cote Gelee hills, date back to the time when elevation, differentially greatest to the northeast, brought the land to such a level that it was ordinarily above the level of the Mississippi waters, being submerged or crossed by them only at extraordinary flood stages. Precisely similar ridges may be seen in the alluvial deposits of almost any stream, great or small. By subsequent greater elevation of the land above even flood stages of the diminishing Mississippi, with a probable differential elevation to the southwest, these transecting channels became clogged and were converted into the flats and swamps as we see them today. These are bottomed at a few inches, or at most two or three feet depth by the yellow loamy clay of the ridges. Only Deer creek of all the numerous *coulees* from the Arkansas line to Sicily Island has maintained and deepened its channel across this zone of bluff deposits, and this was made possible by the near approach upon the west of the Bœuf and Ouachita rivers.

South of Sicily Island to the Red River the detached areas of bluff deposits lap upon the hills of an earlier geologic period; and the drainage lines across these areas are but extensions of those from the older region, that were partially clogged but not obliterated by the later Columbia clays and loams.

Upon Avoyelles prairie, just south of Marksville, advantage has been taken of one of these coulees—Coulee des

Grus—to connect Choctaw Bayou upon the west with Old River on the east; which was accomplished by a small amount of excavation.

Between Avoyelles prairie and Bayou Cortableau in St. Landry parish, the bluff areas are so small that their drainage is accomplished by short marginal gorges, with steep banks and rapid fall to the surrounding alluvial plain, where they join some small bayou that almost invariably closely borders these island-like areas of bluff.

A noticeable topographic feature of the bluff lands from the Arkansas line southward as far as the Avoyelles prairie, though not so marked as in Southwest Louisiana, is the mounds. Though neither so large nor so numerous as about Lake Charles, they are in all other respects similar. The explanation of their origin offered in a former report applies equally well here. They were there supposed to have been produced by the escape of gases, resulting as one of the products of the reaction between beds of gypsum and decaying vegetable matter. Sulphur was another one of the products. The gypsum is probably of cretaceous age, and the adjacent vegetable bed of lignitic.

Now, the bluff areas under consideration occupy somewhat the same positions upon the *eastern* slope of the cretaceous ridge through the state that the "pimpled prairies" of Southwest Louisiana do upon the *western* slope. Moreover, the existence of *salt* and *sulphur* (probably cretaceous) beneath this region is indicated by the names "Saline Lake," "Saline Bayou" and "White Sulphur Springs"; besides crystals of gypsum are found, and the lignitic group of strata are known to exist a short distance to the west and northwest. Connecting these various evidences, it seems justifiable to draw the conclusion that we had here, upon the eastern slope of the cretaceous backbone of the State, beds of gypsum and beds of lignitic strata; and that the reaction between them has generated the gas, which escaping, has produced the mounds. The smaller size and number of the mounds in this region may be the result of the less thickness of one or both deposits.

Johnson, in his report upon "The Iron Regions of Northern Louisiana and Eastern Texas," makes mention of these

"small mounds or mammillæ" in DeSoto parish; and if it shall develop that these mounds are *general* upon both eastern and western slopes of the cretacious ridge through the State, the proposed explanation will have in this fact strong confirmation. Moreover, the occurrence of these mounds in great numbers and considerable size in any region might suggest the possibility of the existence of important deposits of gypsum or sulphur there. Their small size and infrequency over the bluff areas would hardly indicate mineral deposits of value.

Upon Avoyelles prairie, about Marksville, are also seen the natural ponds described formerly as occurring about New Iberia, and northward along the eastern margin of the mound zone. There is no reason to believe that these are in any particular different in origin from their homologues to the south, and the explanation there proposed is offered again for these.

For a fuller consideration of the bluff lands of the Florida parishes and Southwest Louisiana, the reader is referred to the report upon those sections in "Part III Geology and Agriculture."

The water supply for domestic purposes upon the bluff lands north of the Red river is, so far as learned, obtained chiefly from the water-bearing sands and gravels at the base of the Columbia deposits. This water-bearing stratum is reached upon the *front* lands of Bayou Macon at depths varying from twenty-five to fifty feet; and further west at increasingly shallower depths until near the western edge overlooking Bœuf River bottom, it is not an infrequent occurrence that water is obtained at a depth of ten feet. At Floyd, in West Carroll parish, numerous springs emerge from the base of the bluff fronting in Bayou Macon, and it is believed that this is the outer-crop of the water-bearing stratum to which wells are ordinarly sunk. If so, then the height of the bluff here, which, by aneroid measurement is sixty-eight feet, represents approximately the maximum thickness of Columbia deposits.

The section here, repeated on a reduced scale at Delhi, may therefore be taken as typical of the Columbia deposits

in Louisiana west of the Mississippi alluvium, and north of Bayou Courtableau.

Following is the section:

1. Surface loamy clay, 1 to 3 feet.
2. Yellow clay, slightly mottled, 15 to 20 feet.
3. Red clay, fine grained, with little sand, 20 to 25 feet.
4. Talus, from which springs issue, 5 to 8 feet.

Nos. 1 and 2 of this section find their counterparts in the sections of the Florida parishes and Southwest Louisiana. No. 3 is characteristic of this section of the State, and probably owes its origin to the greater thickness of Lafayette sands and clays to the northwest.

The section displayed by banks of Red river at ferry crossing, about a mile below Cassandria, Avoyelles parish, shows:

1. Red river alluvium thinning toward hills, 10 to 12 feet.
2. Organic deposit, logs, stumps, etc., 1 to 2 feet.
3. Yellow and mottled sandy clay to water, 25 to 30 feet.
4. Bluish quicksand at water level.

This section shows that the Red river in its course *north* of Marksville is a thing of *very* recent date (geologically), having cut through the Columbia deposits and thus separated Avoyelles prairie from Long prairie to the north. A former course was by way of Bayous Bœuf and des Glaises, and its present course was probably made possible by the existence of a coulee analogous to that appropriated by Deer creek north of Sicily Island. This represents the section at extreme low water stage, and when taken the river at this point was so brackish that stock would not drink. Sharks twelve feet long were caught here. The bluish quicksand probably represents the base of the Columbia. The red clay (No. 3) of the Floyd section does not occur in this.

The only mineral deposit of the bluff lands that promises to be of economic importance so far discovered is the extensive and varied deposit of clay. No factories except of the very crudest kind for the manufacture of these clays were seen. The out-crops of excellent clay along Bayou Macon offer splendid opportunities for the manufacture of bricks and tiles.

This bayou is navigable for flats and small boats for much of the year, and the V., S. and P. and N. O. and N. W. railroads and the Mississippi river are within easy reach for shipment of the manufactured products. The parishes of West Carroll, Richland and Franklin have great possible resources in their undeveloped clays.

The vegetable products of these lands are not essentially different from those of other bluff deposits, except insofar as differences in climate and drainage modify them. This is especially noticeable in the tree growth.

Much better and more abundant supplies of oak are obtained here than from the bluff lands of any other section of Louisiana. This has proved an important source of revenue. The merchantable kinds are varieties of white oak, and it is sold in the rough form and shipped to other points chiefly for the manufacture of staves. The trees are sawed into sections of stave length, split up into sizes convenient for hauling, and either hauled to the banks of navigable streams or thrown into smaller streams and floated down to points where they can be taken up by passing boats. I think no factory has yet been built in this section for the preparation of the finished product for commercial purposes. The willow oak grows larger and is much more abundant in the oak and hickory flats of this region than elsewhere in the bluff lands of the State.

On the other hand, the magnolia, which is so characteristic of the bluff lands of the Florida parishes, is entirely lacking between the Arkansas line and Deer creek bottom bordering Sicily Island. This seems to be a result of the want of the genuine loess over this region. There is almost the same lack of wild cane. Upon Sicily Island both the magnolia and cane occur in luxuriant abundance, and are found thence southward. Here the true loess is recognized.

With these modifications, what has been said for the bluff, applies here. It is naturally fertile and productive where proper attention is given to drainage and restoration. The flats, while in their present condition unsuited to cultivation and considered cold and valueless, may be thoroughly drained, and then come to be considered among the best of soils. On account of the even-textured, clayey character of

the land, drainage is largely surface in character, and unless properly directed will rapidly develop destructive washes.

THE MODERN ALLUVIUM.

Under this division is here considered the broad zone (twenty-five to forty miles broad) of modern Mississippi deposits that lie between the bluff-capped hills of Mississippi and Louisiana on the east and the zone of bluff previously described upon the west. This constitutes the present flood plain of the Mississippi River, and in geologic age belongs to the immediate present. Like all flood plains, its topography has scarcely reached the formative stage, being altered by each flood stage of the river, and scarcely to any extent the product of ordinary topographic form-producing agencies. The topography of this section is the result rather of a differential *building up* than of differential *wearing down*.

These alluvial lands are threaded by an irregular network of bayous—sometime channels of the Mississippi itself—which, though sinuous and sluggish, are deep and usually clear. Their ordinary level is much below that of the average flood-plain, and this makes complete and thorough drainage of these alluvial lands by artificial means possible. The natural drainage lines, the bayous, are amply sufficient to dispose of the precipitation upon the flood plain; and it is only when the master stream, the Mississippi, reaches flood stage that drainage is insufficient and the area subject to inundation. The bayous are miniature reproductions of the parent Mississippi, in that each is bounded by its own natural levees, and has its "front" and "back" lands that differ not only in level but in character of deposit. The front lands are invariably higher, coarser grained and more sandy than those back from the bayou; and on this account are more easily drained and first chosen for cultivation.

The alluvial lands of the Mississippi may be classified under four heads, based upon texture and character of drainage. These are: (1) Front lands; (2) back lands; (3) swamp; (4) deep swamp.

THE FRONT LANDS.

As stated above these are the border lands of the Mississippi and all its bayous. They constitute the *natural levees* of all the streams of the region. Marking the lines of greatest checking of current of the sediment bearing streams, here we find the coarsest deposits of the region. As may be seen by reference to physical analyses upon subsequent pages, *sand* is an important constituent of these lands.

The border zone of front lands varies in width from a few hundred yards upon the smaller bayous to several miles upon the Mississippi; the width of the zone at any point being determined by its position upon the concave or convex side of the curve in the river's meanderings.

The *natural* drainage of these lands is *away* from the stream that produced them; but at ordinary stages of the water they may by artificial ditches be made to drain directly into the stream.

The principal tree growth includes several species of oak, water oak and red oak being most abundant; several hickories, including the pecan; sweet gum, and if the soil be very sandy, abundant cottonwood and willow. Perhaps the most characteristic tree of these front lands, especially south of Red river, is the live oak. With its beautiful evergreen foliage and perfect symmetry it is ever the mark of fertile, cultivable lands.

A dense undergrowth of cane and vines accompanies these forests. The front lands pass imperceptibly into:

THE BACK LANDS.

Here the soil becomes finer grained, and the clay element largely replaces the sand. The waters which produced them, after depositing their coarser, heavier sediments near the margin of the channel, became more and more sluggish the farther they receded from that channel, and were thereby compelled to further reduce their load of finer sediments. These lands, chiefly on account of the excess of clay, when under cultivation break up into small rounded masses, and thus justify the name, "buckshot," applied to these soils. Being from one to four or five feet lower than the front lands,

drainage is more difficult and less perfect, and is into the back swamps.

The tree growth is marked by an increase in the number and size of species adapted to a clayey soil and an excess of moisture. Water oak and willow oak become more numerous and larger in size, as do also the hickories. Elm, hackberry and ash begin to appear, and varieties of white oak assume greater importance. Live oak, cottonwood and willow disappear. The same dense undergrowth of cane and vines is found. The percentage of sweet gum increases and an occasional black gum is found.

The back lands in connecfion with the front lands constitute at present the cultivated portion of the Mississippi alluvium. Plantations are laid off with a prescribed frontage upon the river or bayou, and extending a prescribed distance back, usually to or into the back swamp. The front lands, because of their nearness to an unfailing supply of water, their superior drainage and more healthful general conditions are selected as building sites; and those not so utilized together with the back lands constitute the cultivated portion of the plantation.

While requiring different methods of cultivation and best adapted to different crops, the two classes of land are equally prized by the planter. The front lands are more easily cultivated, but they are likewise more easily exhausted than the back lands.

The two questions of *drainage* and *water supply* are perhaps the most important for planters in these alluvial lands. While the hill farmer must use every means in his power to conserve the moisture in his soils, at the same time so directing natural drainage as to protect his lands from waste, the farmer of the alluvial lands is most concerned about being able to dispose of the precipitation rapidly enough for his growing crops. The one must be ever alert lest his drainage ditches get the better of him; the other, lest his ditches become clogged and his crops thereby injured. There is never any fear that the artificial drainage ditches will develop into troublesome gulches as in the hills.

Planters whose plantations front upon the Mississippi

usually find the river so inaccessible, because of steep and muddy banks, that it is little used as a source of water supply. For household purposes two sources are here available: cisterns and wells. In driven or bored wells, water is obtained at shallow depths, but is not considered wholesome. Deeper supplies are better, though so long as the well does not reach the bottom of the alluvium the water will hardly be palatable. Although I am not aware of any wells having been sunk below the alluvial deposits, there is no sufficient reason why they should *not* be, when a pure and wholesome supply would undoubtedly be found in abundance. A well at Baton Rouge, less than 800 feet deep, furnishes a supply of water sufficient for the city and almost chemically pure; and at Baker, La., is an Artesian well which probably has its source in the same water-bearing stratum. May not this same source be found at Port Allen or Plaquemine? Should it be, or should *any* water-bearing stratum be reached *below* the alluvium, the probabilities are that it would produce a *flowing* well. The other source of water for domestic supply is cisterns, either overground or underground. Either of these, if properly cared for, furnishes wholesome supplies of water. As a matter of fact, they are so frequently neglected that they become disease-producing rather than health-giving. Underground cisterns, if walled with brick and then cemented so as to exclude all seapage, and if supplied from a *clean* roof, and, better still, if filled *only* during the winter months, furnish cool, palatable and wholesome water.

Unfortunately the idea is too prevalent that, while man requires wholesome water, *anything* is good enough for domestic animals. Hence we often see horses and mules, from which hard and faithful service is expected, and cows, from which we expect wholesome supplies of milk and butter furnished with water from shallow, stagnant and often muddy pools, which are often little better than cesspools. Plagues, which are directly traceable to these impure sources of water supply carry off thousands of dollars worth of stock annually, and yet there is wonder where the trouble lies. Give the stock, if possible, the same wholesome water we require for ourselves and disease will be much less frequent and fatal.

Unquestionably the cheapest and a very good water supply for stock is that obtained from wells—the deeper the better.

Plantations fronting upon the bayous are rather more fortunate so far as water supply is concerned. For much of the year, during the growing season and periods of abundant precipitation, the bayous furnish very good supplies of water. While not to be compared to cisterns, or wells sunk *beneath* the alluvium, yet they are infintely better than surface pools, and to be preferred to shallow wells. During the long dry summer season, and in the autumn when the leaves from the forests of deciduous trees fall or are carried into them, they become stagnant and foul and should be avoided. This supply could be greatly improved by giving attention to the removal of trunks and branches of trees that fall or are washed or thrown into them and become stranded. These bayous, having no large lateral branches, being supplied chiefly by numerous small streams near their sources are generally clear, and the abode of a great variety of edible fishes.

THE SWAMP.

As the front lands grade into the back lands so these grade into the swamp. The areas thus designated, while not so easily drained as the back lands, are nevertheless capable of *thorough* drainage. They are considered as swamp and useless for cultivation, only because under conditions that have existed in the past they have been too frequently overflowed to make their clearing and cultivation profitable. Under a system of protection that will shut out the flood waters from the master streams they will become available for cultivation. At present they are not so.

Their tree growth consists chiefly of sweet and black with some tupelo gum, large and abundant; abundant ash of sufficient size and quality to make it valuable for manufactures; scaly bark hickory, elm and red maple, white, water and willow oaks, sycamore and cypress. The undergrowth while still dense is marked by a failing of the cane. At present these swamp lands are chiefly valuable for their supplies of hard wood lumber. Their adaptation to cultivable uses while possible must wait upon their greater security from inundation.

THE DEEP SWAMP.

This area, chiefly valuable for its forests of cypress and gum, is subject to too deep and too frequent inundation ever to be used for cultivation, at any rate not until more available lands prove insufficient for the increased population. These are not only subject to inundation from the master streams, but they are the catch basins from which the bayous take their rise. Their inundation is often more than ten feet. They are not sharply defined from swamp lands—from the nature of their origin they could not be—but pass gradually the one into the other. Both are in process of building up, but being checked in this by having their source of materials cut off by the extension of the levees, their further elevation will be exceedingly slow or well nigh cease.

NAVIGABLE STREAMS.

No other section of this State, or indeed of the United States, is so well provided with navigable streams as the alluvial lands of Louisiana. The chief of these is of course the Mississippi, which borders the section upon the east for over three hundred miles from the northern boundary of the State to Baton Rouge, and *passes through* the section thence to the Gulf, a distance of almost two hundred and fifty more, thus giving these lands a frontage of over seven hundred and fifty miles upon the greatest river of the whole earth.

Like all streams flowing into bodies of salt water, there is a rapid shoaling of the river as it nears the Gulf; but by confining the water to a narrower channel and thus increasing the current by means of the jetties a sufficient depth is maintained to permit the entrance of the largest ocean steamers. Once past the shoals there is no physical obstacle to the passage of these vessels at all times as high as Baton Rouge, and for much of the year far beyond the northern imits of this region.

The Mississippi River exceeds all other rivers of the United States in its importance in promoting interstate commerce; so much so that there is a growing disposition to place all means for its improvement wholly in the hands of the National Government. The maintenance of a sufficient chan-

nel at low water stages has long been considered the legitimate work of the National Government; and as the depth of channel at low water stage is directly dependent upon the proper control and direction of the river at flood stage, all means looking to such control should likewise be in the hands of the National Government.

An estimate of the importance attaching to frontage upon this great waterway may be had by a consideration of the increased valuation of these lands over equally productive lands more remote from the river. While cultivated lands fronting upon the Mississippi River are valued at from $75 to $100 an acre, and are not in the market, lands in every other particular similar, but removed from a navigable stream may be had in almost any desired amounts at from $5 to $25 an acre. The vast difference in price now existing is abnormal, and must eventually decrease.

Next in importance to the Mississippi River proper is its principal tributary, the Atchafalaya. While vast amounts of money have been spent in *maintaining* a sufficiently deep channel in the parent river, here we see engineering skill taxed to *prevent* a further deepening of the channel. The former task has proven the easier and has been much more successfully accomplished.

A probable former route of the main channel of the Mississippi, but abandoned because of differential elevation to the southwest, the Atchafalaya has continued to the present a distributary for the flood waters of the parent stream. During the ages that record the eastward shifting of the Mississippi the mighty river has carried its burden of sediment to the sea, and consequently lengthened its course and decreased its slope. At varying intervals long and sinuous routes have been abandoned for shorter and more direct, while at the same time distributaries have been maintained for the disposal of flood waters.

As differential elevation to the southwest was probably influential in causing the river to shift from the western to the eastern side of its broad valley, so it may be that a similar differential elevation in the southeast has hastened the abandonment of its outlet through Lake Pontchartrain for a

more westerly and present course. Whatever the combination of causes a greater and greater volume of water at flood stages pours through the Atchafalya, until now the prospect is that this may, in the *natural* order of events, *again* become the route of the main river to the gulf. It offers a shorter, more direct and consequently much steeper gradient than the present channel of the Mississippi, and there is an increasing tendency to follow it.

The Atchafalaya has rapidly increased in breadth and depth in recent years, having increased in cross-section more that fifteen per cent. since 1890.

At this unprecedented rate of development it would not require many years for it to divert first the waters of Red river, and but little later the upper Mississippi. This would be river piracy on the grandest scale perhaps known to history, and to prevent it is now the work of engineers.

The increase of volume of the Atchafalaya has been attended by an increase in importance for commercial ends. Its upper waters are plied regularly by numerous smaller craft, and would accommodate the largest river steamers were its connection with the Mississippi sufficient. This will almost certainly be made sufficient in the near future, when the development of this fertile district begins in earnest.

The Atchafalaya, in common with every river of importance in Southwest Louisiana, expands in its lower course into a broad, shallow lake. Below these lakes is a deep channel to the sea. In them the current of the streams is so checked as to permit the deposition of almost all of the sediment carried down to them. This deposition is hastened by their proximity to the gulf, which often renders them brackish. These lakes offer the chief hindrance to coastwise vessels ascending the rivers, often for a distance of from fifty to seventy-five miles, and, in the case of the Atchafalaya, to its source.

The expansion in the Atchafalaya, known as Grand Lake, is the obstacle in that stream to its wide usefulness as a water communication with the gulf. By judicious dredging and construction of retaining dikes, it is believed a navigable channel can be maintained through this and similar lakes,

and the advantages of deep and safe harbors thus secured to points far inland. The invariable shoaling at the extreme mouths of the streams may be overcome as it has been at the mouth of the Mississippi.

Grand River and Bayou Lafourche, by reason of their connection with the Mississippi, thus establishing a permanent water supply, are important navigable streams in the lower alluvial regions. Bayou Manchac could in similar manner be made a valuable stream upon the east, as also numerous shorter distributaries for the lower river. East of the Atchafalaya and north of Bayou Plaquemine the bayous are too small to be of more than local importance, but these could be made much more useful by clearing them of the drift with which they have become clogged.

Tributary to the Atchafalaya upon the west are the two important bayous, Teche and Cortableau. These, though dependent upon precipitation over their basins for their supply for a considerable period during the year, are navigable to Arnaudville and Washington, and are important carriers for the produce along their routes.

The Red River has more than fifty miles of its lower course through the Mississippi alluvium and is navigable throughout the year; and its only important tributary in this region from the north—Black River—is of about equal length and likewise permanently navigable. North of Trinity, in Concordia parish, the Ouachita and the Bœuf rivers pass west of the bluff lands, and are both navigable streams, the Ouachita permanently and the Bœuf at flood stages, while in the alluvial lands proper no permanently navigable stream for other than extremely small craft occurs. The Tensas River and Bayou as far north as the V., S. and P. R. R. and Bayou Macon and Joe's Bayou to the latitude of Floyd are locally of great importance, inasmuch as they not only put the section through which they pass in touch with distant markets through the Ouachita River, but by way of the V., S. and P. R. R. as well. These bayous could be made navigable for much larger boats and for considerably longer periods with very small expense devoted to judicious dredging and clearing of rafts and drift. A channel once opened in these streams

does not readily silt up for the reason that the waters entering them are filtered in the swamps, and thus bring but little sediment. The streams are clear, except when the Mississippi breaks through its levees in Arkansas or North Louisiana and pours a flood of sediment-charged water into them. Such unnatural flood stages are the only times when they overflow their banks.

No section of the State offers greater returns for improvement of its water courses than the alluvial lands of the Mississippi north of Red river, comprised in the parishes of Concordia, Tensas, Madison and East Carroll. The intricate network of bayous makes this region, for much the greater part, easily and thoroughly drainable, and reduces the area of deep and uncultivable swamp land to an exceedingly small one. The larger bayous, having their channels cut deep and wide by volumes of water that no longer pass regularly through them are scarcely different from so many great, sinuous, artificial canals, which serve to bring the products of the farm within easy reach of the markets.

This section has likewise been the greatest sufferer from insufficient protection against pent-up floods of the Mississippi River. Many thousand acres of most fertile land, which was considered safe from inundation when the Mississsippi had simply to overflow its natural levees to spread over its flood plain, and which had reached a high state of cultivation, have been practically abandoned as unsafe, or at least unprofitable, since the development of the levee system began. The floods in the Mississippi, restrained for a time, have finally burst their bonds and practically depopulated many formerly populous sections; witness the once beautiful and prosperous, but now almost forgotten village of Monticello, in East Carroll parish, on the bank of the Macon. With the perfection of the levees, loss from inundation has become less frequent, but the feeling of insecurity even yet prevents this section from taking the former high rank it once occupied among the agricultural sections of the State.

PROTECTION AGAINST OVERFLOW.

While it may not seem the province of this report to enter

into a detailed consideration of the vexing question of protection against Mississippi floods, yet inasmuch as it is to some extent, at least, a question for the geologist, brief consideration is here given. This seems all the more proper when it is remembered that the primary object of the report is agricultural, and anything that looks to the betterment of lands now under cultivation, or the reclamation of other available lands, finds a proper place here. Already one of the most important agricultural sections of the State, the Mississippi alluvial lands, would be many times multiplied in their assessed valuation were there a feeling of *perfect* security against floods from the parent stream. Any proposed means looking to increased security should be welcomed.

It would seem a safe principle that any *artificial* means for protection against floods are the better the nearer they follow *natural* means adopted by the river itself. If this be true, then the bitter controversy between the advocates of the "all-levee" and of the "outlet" systems of protection must be settled upon compromise ground.

Every river emptying into the sea through a broad flood-plain builds *natural levees* along the borders of its channel, and maintains distributaries, or *natural outlets*, that serve as means of protection to the flood-plain against all except flood stages of the river. Not only the parent stream, but, on a smaller scale, the distributaries themselves build natural levees. If all streams, in their natural state, adopt these methods, then an extension of these would seem to be the safe and proper means of complete protection against floods. The master stream and all distributaries would require a strengthening and enlarging of their natural levees. Such distributaries that might thus be made to do service as outlets in time of flood are, Bœuf River, Bayous Bartholomew, Macon and Tensas, Atchafalaya River, and Bayous Plaquemine and Lafourche upon the west, and Bayou Manchac upon the east. Other short artificial canals would make outlets into Lake Pontchartrain and into the series of lakes opening into Barataria bay.

If necessary the Red River could be easily made to empty its waters through the Atchafalaya river when the stage of

the Mississippi demanded it. As the maintenance of an unobstructed Mississippi as a highway of commerce not only between states, but between this and foreign countries is a question of national concern, the maintenance of the levees and proper connection with outlets are matters that may very properly be turned over to the National Government. The leveeing of the distributaries, being for the advantage of the state in which they occur, is properly a matter for the state to attend to.

With well constructed levees along the parent stream, and properly maintained outlets, the danger from overflow would be reduced to such an extent as to amount almost to security, and the immediate effect would be to make available and give value to many thousand acres of most excellent farming land that is now avoided from fear of inundation.

To make assurance against overflow doubly sure, the following suggestion is offered in regard to the further protection by the construction of additional levees: It is a well established principle that a stream of given volume flowing through its flood plain will meander within certain prescribed limits. In the case of the Mississippi these limits are marked by the convex sides of "horseshoe lakes," "old rivers" and other sections of the old and temporarily abandoned channels. Beyond these limits the river has no power to go, and within them it may periodically occupy every part. The present system of levees follows the present channel as closely as seems advisable, and must from time to time be rebuilt, because of encroachment of the river upon them. About the location of such levees we have nothing to say. A system of levees, built by the State, equally strong with the present levees, but located so as to be *tangent* to the abandoned sections of the old channel would be much less expensive in their initial construction than the present levees, as they would be much shorter; would never have to be rebuilt by reason of the encroaching river, and would reduce the danger of inundation from crevasses to a minimum. It is such a system we would advocate for the reclamation of the alluvial lands of the Mississippi. Such levees would make most desirable railroad beds, both because of directness and

of location in one of the richest agricultural regions of the globe, and would, no doubt, be sought for such and thus be of but slight or no ultimate cost to the State. If desirable, these levees could, with but slight additional cost, be connected with the front levees at intervals by short cross levees. The drainage of the inter-levee region could be easily maintained, and the main objection to the scheme would be its initial cost. This would be far more than repaid to the State in the increased valuation of its lands, produced by absolute security against inundation from crevasses.

CULTIVATED CROPS.

But little need be added to what was said in "Part III Geology and Agriculture," concerning the cultivated crops of the bluff lands. These, perhaps, above all other lands in the State, offer the best opportunities for diversified agriculture; and offering, as they do, so many advantages for the building and beautifying of homes they are naturally sought by those planters and farmers who prefer country life. Though formerly considered valuable chiefly as cotton lands, recent experiments at Baton Rouge have demonstrated their suitability to the growth of a superior grade of cigar wrapper tobacco. The possibilities of these lands for tobacco culture are very promising. Their value as sugar lands is likewise increasing. Long ago sugar cane was successfully and profitably grown upon the bluff lands at Baton Rouge, but with the advent of central factories that bought cane by the ton without regard to the sugar content, cane culture on the highlands was abandoned for the more productive alluvial lands. Now that there is a growing disposition on the part of sugar factories to recognize the higher value of a cane with high percentage of sugar; and since it is a well established fact that cane grown upon bluff lands contains a higher percentage of sugar than that grown on the alluvial lands, sugar planters are again turning their attention to the highlands, since these lands are more easily and cheaply cultivated than the modern alluvium.

The alluvial lands have been pre-eminently the homes of the large planters. The great staple crops, cotton, sugar and

rice, have been, and are still produced in abundance. As each in turn has been most profitable planters have turned their attention to its culture. Since the discovery of the suitability of the great prairie region of Southwest Louisiana for rice culture, the Mississippi alluvial lands have been turned almost exclusively to cotton north of Red River and cotton and cane south of it. Below Baton Rouge but little cotton is grown. These cane lands of South Louisiana are divided up into large holdings, and diversified agriculture for profit upon them is a thing unknown.

Although it would be to the interest of the State for these lands to be owned in smaller tracts by men who lived upon them, and thus had an interest in building up educationally and morally the sections in which they lived, yet, so long as our economic system is such as to make possible the accumulation of large fortunes in a few years by planting vast tracts in a single crop, planted, cultivated and harvested by ignorant and uninterested labor under intelligent though equally uninterested direction, just so long will our rich alluvial lands yield up their riches to the few rather than support the teeming home-making population of which they are capable.

In these alluvial lands, in the parish of St. James, is the now famous Perique tobacco section. No doubt the same intelligent cultivation and handling of the crop would secure equally good returns of this much-prized variety of tobacco in almost every other section of our alluvial lands. Without physical and chemical analyses of the soils it is impossible to discover here any peculiarities of soil that would make this particular region suitable for any single crop above other alluvial lands.

Recent experiments at Audubon Park with alfalfa have demonstrated very fully the pre-eminent suitability of Louisiana alluvial lands for that desirable crop. From five to eight cuttings a year, yielding as much as one and one-half tons of hay per acre per cutting, have been obtained. When it is remembered that most of our hay is shipped from the Northwest and costs us from $10 to $15 per ton, and that this may be to a great extent replaced by alfalfa, we may arrive at an appreciation of the value of this crop, whether grown for home

consumption or for profit. Bermuda and carpet grass are the chief grazing crops of the alluvial lands and furnish good pasturage for most of the year. Sorghum, Indian corn and cow-peas are important cultivated forage crops.

Near New Orleans, market gardening has proven very profitable, and with quicker time and cheaper rates to the Northern markets this industry will be capable of almost indefinite extension.

In the extreme southern part of this region orange culture has brought good returns. It is believed that many fruits will be found suited to this soil and climate, but beyond the experiments made at Audubon Park but little is known of the possibilities along this line.

FISH AND OYSTERS.

Scarcely better fishing grounds can be found than those offered by the multitude of bayous, lakes and rivers of these alluvial regions. From the Arkansas line to the Gulf the waters teem with the greatest variety of edible fishes. Though chiefly of local importance, furnishing to a vast majority of the population a very good substitute for beef and pork, in a few places the fish industry assumes importance. At Melville and other points along the Atchafalaya, great quantities of catfish are shipped. The markets of all the villages are supplied with a good variety of fishes from nearby streams. As we approach New Orleans and the Gulf, the industry assumes greater importance, and the lakes and coastal waters teem with fishing craft.

In the coastal bayous and bays along the gulf the oyster culture has developed rapidly, and now our Louisiana oysters may be seen in distant markets, and are esteemed by many superior even to the Chesapeake Bay oysters. The oyster industry, already important, is rapidly expanding.

III. SOILS.

Although it was the original intention to include in this report a discussion of the soils of the region examined, it is now thought best to present this as the final supplement of

the reports upon the preliminary survey of the State. A large number of typical soils have been collected and are now being analyzed in the chemical and physical laboratories of the survey. Upon the completion of these analyses a full discussion of them, together with a soil map for the entire State, will be published. It seems sufficient here to say, that in regard to the "bluff" lands from the northern limit of the State southwest there is a gradual, though not regular, decrease of the *loam* and a corresponding increase of the *clay* element in the soil. In like manner the more recent alluvium is characterized by a failing of the sand constituent as we go southward. There is not, however, as great a variation in the physical constitution of the soil from the Arkansas line to the Gulf as may be observed in passing from the "front" lands along the Mississippi back to the "deep swamp." In both cases the difference is due to deposition of sediment from checking of current upon less steep gradients.

Aside from the variation of the chemical composition of the soil, due to a difference in the amount of sand, there is little difference chemically in the character of the alluvium in East Carroll parish and at New Orleans. The difference of plant growth in the two regions is due chiefly to differences of climate.